Late responses & Reflexes

- F-wave
- A-wave
- H-reflex
- T-wave
- Blink-reflex
- Flexion-reflex
- Interlimb reflex
- CMAP followers

F-waves - normal

F-response generation

antidromic conduction  SD invasion  recurrent impulse
F-waves - normal

Pooled F-latencies for arm and leg nerves; min, mean and max - normal material

Number of F-waves/20 stimuli in healthy subjects
Number of F-waves/20 stimuli in healthy subjects

NERVE: n.peroneus

NERVE: n.tibialis

F-waves – diabetic neuropathy

F-waves - conduction block

Puuksa, Falck, Stålberg  unpubl

F-waves – diabetic neuropathy

Number of F-waves/20 stimuli in healthy subjects

NERVE: n.peroneus

NERVE: n.tibialis

F-waves – diabetic neuropathy

F-waves - conduction block

Puuksa, Falck, Stålberg  unpubl
There are more F-waves on the right side, central lesion.

F-responses - normal

F-responses - demyelination

Stålberg
F-responses – conduction block

CMAP n
F ampl n
F # few

F-responses – normal

CMAP n
F ampl n
F # n

F-responses – axonal loss

CMAP 50%
F ampl n
F # 50%
F-responses – chronic neurogenic

CMAP: n
F ampl: 200%
F #: 50%

F-responses – myopathic condition

CMAP: 50%
F ampl: 50%
F #: n

F-responses – spasticity

CMAP: n
F ampl: 200%
F #: 200%
F dispersion
A-waves

N Medianus

Intermediate responses

axon reflex  extra discharge (IDD)  ephaps  M satellite

Stim position is moved in proximal direction

If M-lat increases and A-wave lat decreases, the site must be prox
IDD and M-satellites - different pathophysiology

- IDD myelin defect, channel (K⁺ defect)
- M-satellites, axonopathy

IDD and M-satellites can be differentiated

Moving stimulating electrode
Double stimulation

Moving stimulation in proximal direction

If M-lat increases and A-wave lat decreases, the site must be prox
If M-lat increases and also A-wave lat increases, there is an M-satellite
The stimulating electrode at the wrist, 80 mm, is moved proximally to 100 mm. Note that the late response is delayed parallel to the CMAP.

The stimulating electrode moves from 80 mm to 100 mm. The late response is delayed in parallel to the CMAP.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Patients</th>
<th>Controls</th>
<th>Puuksa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median nerve</td>
<td>2.0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Ulnar nerve</td>
<td>2.5</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Peroneal nerve</td>
<td>11.9</td>
<td>0</td>
<td>14</td>
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<tr>
<td>Tibial nerve</td>
<td>25.1</td>
<td>4</td>
<td>25</td>
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</table>
### Frequency of A-wave findings

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>% of patients with A-waves in the group</th>
<th>% of A-waves found in:</th>
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</thead>
<tbody>
<tr>
<td>Polyneuropathy</td>
<td>64.7</td>
<td>53.2</td>
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<tr>
<td>Nerve root lesion</td>
<td>47.8</td>
<td>17.7</td>
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<tr>
<td>Entrapment syndromes</td>
<td>5.4</td>
<td>5.6</td>
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<tr>
<td>Motor neuron diseases</td>
<td>60.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Guillain-Barré Syndrome</td>
<td>71.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Plexopathy</td>
<td>27.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Postpolio Syndrome</td>
<td>10.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Myopathy</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other diagnosis</td>
<td>10.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Without other clinical or neurological pathology</td>
<td>5.1</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Reflexes
H-reflexes

- Stimulate Tibial nerve at the knee
  - stim strength: low
  - duration: 1.0 ms
  - frequency: 0.5 Hz

- Record over soleus/lat gastrocnemius muscle

- Abnormal in:
  - S1 root
  - PNP
  - myelopathy
Recording from different branches of the facial nerve

Elektrode placement
Blink reflex

Blink reflex - principle findings

- normal
- R. facialis
- R. trigeminus

Flexion reflexes

N Peroneus
Long latency responses in prior polio

Interlimb reflex (ILR) from VL at ipsilat plexus stim
Startle response from VL at contralat plexus stim

Activity between CMAP and F-response
- variable shape

• Extradischarges
  – Acetylcholine induced
  – Channelopathies
  – Neuromyotonia
  – Myotonia (PEMD)

Extradischarges in Mestinon overdose

• Some special features
  – Irregular
  – Disappear with stim frequency > 2Hz
  – May be repetitive discharges
Is this bad relaxation?

Cholinergic extra discharges

Same patient, CMAP tail

Cholinergic extra discharges

3 runs, CMAP tail of variable late components

Cholinergic extra discharges

41791, per
Cholinergic extra discharges, pronounced (A), slight (B)

Extra discharges at rest after stimulation may be seen in:

- MG with anticholinesterase overdose
- myasthenic syndromes
  - cholinesterase deficiency,
  - slow channel syndromes
- organophosphate intoxication
- neuromyotonia
Post exercise myotonia discharges (PEMD)

- CMAP after a short period of voluntary activation may be followed by irregular discharges in myotonic disorders

PC, Short exercise
TH35M sodium

Activity between CMAP and F-response
-constant shape

- A-waves
- IDD
- M-satellites
- Ephaptic transmission
- Axon reflex
- Repeat F-waves
- H-reflex
Stable late responses (A-waves)

- Axon reflex
- Extra discharge (IDD)
- Ephaps
- M satellite

A-waves

N Medianus