Late responses with variable latency

- F-waves
- Extra-discharges in the end-plate
- (Reflexes)

Generator site for late responses;

F-waves

F-waves - normal

F-waves – diabetic neuropathy
GBS, loss of F-waves = conduction block

Extra-discharges in the nm-j or muscle

- Acetylcholine induced (overtreatment, organophosphates)
- Channelopathies
  - Slow channel syndrome
  - Myotonia (PEMD)
- Motor neuron pathology
  - Fasciculations
  - Other spast activity

Is this bad relaxation?

Cholinergic extra discharges

Cholinergic extra discharges, pronounced (A), slight (B)
Late responses with constant latency

- A-waves
  - IDD
  - M-satellites
  - Ephaptic transmission
  - Axon reflex
- Repeater F-waves
- H-reflex

Intermediate responses

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

Congenital myasthenia (slow channel)

Cholinergic extra discharges disappear at 3 Hz stim

Benign fasciculation syndrome? OR Neuromyotonia (K+ channel)?

Interlimb reflex. Stim right ulnar nerve
GBS A-waves and few F-responses

A-waves (and repeaters) in GBS

A-waves in a patient with Guillain Barré syndrome

Stim position is moved in proximal direction

If M-lat increases and A-wave lat decreases, the site must be prox
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.

**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>
</tr>
</thead>
<tbody>
<tr>
<td>Polyneuropathy</td>
<td>64.7</td>
<td>53.2</td>
</tr>
<tr>
<td>Nerve root lesion</td>
<td>47.8</td>
<td>17.7</td>
</tr>
<tr>
<td>Entrapment syndrome</td>
<td>5.4</td>
<td>5.6</td>
</tr>
<tr>
<td>Motor neuron disease</td>
<td>6.0</td>
<td>6.8</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>Femoral-Bs Syndrome</td>
<td>1.6</td>
<td></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 neurophysiological pathology</td>
<td>5.1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**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

**Dispersion in CIDP**
Late resp

CMAP-satellites, terminal slowing
PNP; Tib n. ankle and knee stim

M-satellites, terminal slowing
PNP; Tib n. knee stim

M-satellites, terminal slowing
PNP; Tib n. knee stim

M-satellites, terminal slowing
PNP; Tib n. knee stim, 3 superimposed
Late responses

Dispersion, below fibula head

Dispersion, across ulnar sulcus

Late components after the CMAP

<table>
<thead>
<tr>
<th>Type</th>
<th>Immediate</th>
<th>Intermed</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-waves</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMAP-satellites</td>
<td>X</td>
<td>X</td>
<td>(x)</td>
</tr>
<tr>
<td>F-waves</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H-reflex</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>flexion reflexes</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>C-waves</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Some late components after the CMAP are seen in healthy

Others indicate pathology; look for them -you can do that in every EMG lab- and try to interpret them, they tell a lot

Summary