The Integration of Neurography and EMG

Erik Stålberg
Uppsala, Sweden
# Neurography and EMG, the integration

<table>
<thead>
<tr>
<th>Condition</th>
<th>neurography</th>
<th>RNS</th>
<th>auton</th>
<th>EMG</th>
<th>SFEMG</th>
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Place of EMG

1. Ways to express EMG abnormality
2. MUP and IP analysis
3. Neurography and EMG, integration
What do we want to express

- Muscle membrane function - spontaneous
- Muscle fibre characteristics; diameter
- MU organisation
  - number of fibres
  - grouping
- N-M transmission
- # motor units
  - total
  - activation; pattern, fullness
Neurography in muscle disorders

• Indications
  – concomitant neuropathy? (mitochondr, pm, paramalignancy, secondary entrapment)

  – use CMAP to assess muscle bulk
Neurography in MND/MMN

**MND:**
Exclude axonal neuropathy
Confirm normal SCS
Exclude MMN

**MMN:**
Demonstrate motor cond block in individual motor nerves
Confirm normal SCS
EMG in pnp

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EMG in pnp, MUP summary

Accepted MUPs

<table>
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<tr>
<th>Left Tibialis anterior</th>
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MUP

IP

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EMG in pnp, jiggle + poly
EMG in St p polio

Normal

Polio

Vast lat
Small fiber testing

- Autonomic test (RR, SR)
- Epidermal nerve fiber density
- Thermotests
- Near nerve needle neurography
- Microneurography
- Special neurography methods
Epidermal nerve fibres

ENF

Courtesy of Mellgren, Løseth
Other investigations for muscle

• CK
• Muscle biopsy
  – morphology
  – histochemistry
  – electromicroscopy
  – metabolic factors
• Genetic studies
• MRI
• CT
• Ultrasound
Other tests in MND

- **MUNE**
  - Reduced # MU should be assessed in MND, St p polio
    - electrical stimulation (incremental, dual stim sites, statistical)
    - voluntary (MUNIX)

- **TMS**
  - Excitability (threshold and PSTH)
  - CCT
  - TST
## CTS, palmar inteross and 1st lumbrical

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<th>Rec: APB</th>
<th>0.5 mV/D</th>
<th>3 ms/D</th>
<th>48.3 m/s</th>
<th>-21 %</th>
<th>-28 %</th>
<th>-12 %</th>
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- **Latency (dLAT/CV):** 5.8 ms
- **Amplitude (AMP):** 2.8 mV
- **Area:** 10.3 mV ms
- **Duration (DUR):** 6.2 ms

### Additional Details

- Temperature: ***
- H-reflex:  
- Le&RI:  
- Note:  
- Run: 1, 2, 3, Mix, AllCh, Note, Edit text
EMG in myotonia

• confirm myotonic discharges
• is EMG myopathic or not
• explore distribution (prox-dist)
• effect of temperature
• effect of activity
Neurography in St p polio

• No primary reason
• Atypical symptoms need further EDX
  – neuropathy (pnp, entrapment)
EMG in St p polio

- confirm neurogenic involvement
- find subclinical involvement
- assess degree of MU loss
- find other cause of symptoms:
  - entrapment, radiculopathy
Neurography in MG

- No primary reason for neurography

- Used when picture is atypical and when RNS and SFEMG are negative

- **NOTE:**
  - during any neurography low CMAPs should alert the examiner on nmj problems (remember to test facilitation in routine and in ICU)
SFEMG in MG

- assess increased jitter (same as jiggle in conc EMG)
- confirm normal FD

- not expected
  - increased FD (reinnervation)
  - normal jitter in 20/20 recordings
EMG in CTS

- EMG NOT necessary for the diagnosis *per se*. Neurographic methods are sensitive and specific.

- If EMG is used,
  - the question is to exclude roots; in Ext Carp Rad (C6) and EDC and Flex carp rad (C7)
  - in APB it may answer the question of amount of axonal lesion (but CMAP is usually better)

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Autonomic tests, RR, SSR

- To assess involvement
  - in GBS may be vital
  - small fiber involvement
  - specific conditions, e.g. amyloidosis,
EMG in Musc Dystr

• Typical findings
  – spont activity
  – small polyphasic MUPs
  – early recruitment
  – dense or reduced IP (severity)

• Not expected
  – normal EMG - think of non dystrophic cond.
  – myotonia
Neurography in Musc dystr

• No primary reason for neurography
  If performed:
  • Expected findings
    – low motor ampl,
    – normal MCV
    – F waves low ampl, normal persistence
    – normal sensory ampl

• Not expected
  – abnormal neurography (think of mitochondrial cond, paramalignant condition)
Neurography

- pathophysiology: demyelinating/axonal/CB
- fiber type: sensory/motor/autonomic
- fiber size: large/small
- distribution: distal/proximal
- severity
Neurography in GBS

- demonstrate acute motor and sensory neuropathy
- demonstrate conduction block
- assess: severity, pathology, distribution

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Neurography in root/plexus

• Sensory (with sensory symptoms)
  – normal distal amplitudes - root or CB anywhere
  – reduced distal ampl - axonal plexus involvement

• Motor (with weakness)
  – reduced distal amplitudes - axonal lesion
  – normal amplitudes - CB
Neurography in focal lesion

Motor symptoms:
- pathophysiology and severity
  - demyelinative or CB focal testing (SSS)
  - axonal SSS may not help, go to EMG

Sensory symptoms:
  - low distal amplitudes go to other nerves, + EMG
  - normal distal ampl find focus (if not, make SEP)
Neurography in CTS

• to assess:

• pathophysiology:
  – demyelination latency
  – axonal distal ampl
  – CB block across ligament

• fiber type
  – sensory/motor

• severity

CTS severity

- very slight: only relative abnormality (other nerves; uln mot, uln sens, rad sens)
- slight: only sensory abnormality
- moderate: sens + motor
- severe: no sens resp, motor abnormality
- very severe: no responses
EMG in GBS

• EMG in Early phase:
  – No indication
  – MUNE (but only MUNIX which includes voluntary act)

• EMG in Late phase:
  – degree of axonal involvement
  – jiggle
  – IP
  – Macro
EMG in MG

• No indication in diagnostic work up
• If SFEMG is neg, EMG is indicated to find alternative diagnosis to MG
EMG in MND

• To confirm
  – generalized denervation
  – fasciculations
• To exclude myopathy

EMG in MMN

• To demonstrate focal/multifocal denervation

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Neurography in myotonia

• NCS is usually not necessary when EMG has confirmed myotonia
• When myotonia is suspected, it is wise to start with EMG
RNS in MG

• Least sensitive method. If this is pos. and typical, MG is highly suspected.
  – proximal muscles
  – no treatment
  – warm muscle

• exclude (think of…)
  – LEMS, myotonia, Mc Ardle, cong MG
EMG in PM/IBM

• Expected positive findings
  – myopathy
  – spont. activity (fib, CRD) (th. paraspinals)

• Not expected
  – normal EMG
  – neurogenic pattern (except in end stage)
  – myotonia
**EMG in focal nerve lesions**

- **Localize site**
  - pure axonal focal lesion cannot be defined with neurography
  - root lesions (involvement of post rami= root, ant rami for segment)
- **assess degree of axonal damage**
- **follow reinnervation** (spont activity, conventional MUP parameters, jiggle, IP)
- **MUNE/MUNIX**
Why EMG in pnp

Not always necessary….but possible objectives are to:

• assess amount of axonal damage
  – long nerves
• assess dynamics
  – jiggle
• assess distribution
  – distal/prox
  – asymmetric
• exclude other reasons of symptoms
  – distal myopathy
• find clue to underlying condition
  – neurotonia
Neurography in GBS

• confirm MOTOR-sensory demyelinating pnp
• confirm conduction block (MCS, F persistence)
• assess site (prox-dist --antiMAG)
• assess amount of axonal involvement (CAMP ampl)
• autonomic involvement

• NOTE:
  – CB due to high temperature
  – nerve hypoexcitability
**Distribution of conduction slowing**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Proximal</th>
<th>Even</th>
<th>Distal</th>
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<tbody>
<tr>
<td>GBS</td>
<td>+</td>
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<tr>
<td>CIDP</td>
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<tr>
<td>anti MAG</td>
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Conduction block in MMN
MRI in muscle disorders

Titinopathy (Udd)

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Courtesy Torbergsen, Löseth
Numbness dig IV-V
“uln sens ampl low”

Ulnar sens
ampl low

dors br normal

confirm
Gyons canal

uln inching
abnormal

confirm
local entrapment
around elbow

EMG abn
IOD
APB
EIP

confirm
inf. trunc

EMG abn
IOD
APB
not EIP

confirm
med cord
Numbness dig IV-V
“uln sens ampl normal”

uln inching
abnormal

confirm
local entrapment
around elbow

ulnar inching
normal

EMG
paravert C8
IOD, APB, EIP

abnormal
findings

confirm C8

normal
findings

SEP

confirm level
Weakness in ICU, start with neurography

- Weakness in ICU
  - MCS
    - Low ampl low CV: confirm GBS
  - SCS
    - Low ampl normal CV: LEMS, botulism per. weakness mot axonopathy crit illness
    - Low ampl low CV: crit illness
    - Low ampl normal CV: intoxication sens axonopathy crit illness

If neurography normal - go to EMG
Weakness in ICU

EMG

Profuse denervation
- dense IP
  - low ampl
  - myositis? crit illness?
- reduced IP
  - axonopathy
  - neuronopathy

No denervation
- low freq
  - central weakness

Myotonia
- channelopathies

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