Neurophysiological tests in MND

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Clinical types of ALS

• Sporadic ALS
• Genetically determined ALS
  – SOD-1 mutations
• Two clinical forms
  – Spinal ALS
  – Bulbar ALS

Clinical hallmarks of ALS

• Painless weakness and atrophy in several regions
• Often focal onset
• Increased reflexes
• Progressive history
• Imaging and other tests exclude other diagnoses

EMG findings

Neurogenic EMG
(has the same significance as clinical LMN signs)

*EMG features
• MUP: Increased ampl, dur, phases
• MUP complex, with jiggle
• Decreased recruitment=rapid firing in red # of MU. (UMN may give low firing)
*Fibs/-psw usually in strong non-wasted muscles
*In neurogenic EMG, fasc, preferably complex have the same significance as fib-psw
Generalized tongue atrophy in ALS

Fasciculations

- FP in ALS
  - Complex, jiggle (instability)
- Benign
  - Simple, stable
- Benign FP normal
- Complex FP
  - can alone not make ALS diagnosis
  - not always present in ALS
  - can be seen in other neurogenic disorders

MUPs in a normal subject

MUPs in a patient with ALS

Peripheral nerve in ALS
Neurography, to exclude other disorders

• "Normal SNS"
• MCS, CV >75% of normal, F <130% of normal
• Distal latency and dur < 150% of normal
• Absence of CB and dispersion
• CMAP ampl often low
• If CMAP ampl < 2 mV, CV value low

“Sensory normal”

Upper motor neurone testing

EDX signs of UMN

• Low irregular firing rate of MUPs
• Increased F-persistence (Stålberg unpubl)
• TMS
  – Decreased / Increased threshold
  – Increased CMCT (30%)
  – Increased absolute latency
  – Absent limb responses in pat with bulbar symptoms supports UMN
• Triple stim technique sensitive, needs confirmation

ALS criteria

• El Escorial WFN criteria (Brooks), 1994
• Revised El Escorial criteria, Airlie House 2000
• Awaji Island criteria, 2008

http://www.wfnals.org
Modified criteria, Awaji Island, Japan, 2006, publ 2008

Electrodiagnostic criteria for diagnosis of ALS

De Carvalho, Dengler, Eisen, England, Kaji, Kimura, Mills, Mitsumoto, Nodera, Shefner, Swash

Some news compared to El Escorial

- EDX equally important as clinical signs
- Fasciculation potentials (FP) indicate ongoing denervation, equally important as fibs/psw
- FP are complex and unstable
- FP in ALS usually start distally
- Jiggle of MUPs is useful information

Clinically definite ALS
Clinical or EDX evidence of:
LMN + UMN in bulbar and at least 2 spinal regions
or
LMN + UMN in 3 spinal regions

Clinical probable ALS
Clinical or EDX evidence of:
LMN + UMN in at least two regions with some UMN rostral to the LMN signs

Clinically possible ALS
Clinical or EDX signs of:
UMN + LMN dysfunction in only one region
or
UMN in two or more regions
or
LMN rostral to UMN signs
and
Other diagnoses excluded (imaging + lab tests)

Monitoring changes over time
Change in force and CMAP-amplitude in a patient with ALS

Motor unit number estimation (MUNE)
Rate of loss of MU-function in patients with ALS

Serial MUNIX Measurements in ALS: Hypothenar

EDX strategies

Principle strategy of EDX in ALS
- Confirm LMN dysfunction in clinically affected regions
- Detect electrophysiological evidence of LMN dysfunction in clinically uninvolved regions
- Exclude other pathophysiological processes

Practical strategy of EMG in ALS
- Chose some weak/atrophic muscle and some clinically normal
- Muscles should repr different nerves and segments
- Assess fib-psw, fasc pot (frequency, shape), MUP parameters incl jiggle, IP
EMG in ALS, suggested muscles

• Spinal:
  – IOD
  – Biceps
  – Paraspinal Th10
  – Rect abd
  – Tib ant
  – Vast lat

• Upper cervical and bulbar
  – Trapezius
  – Sternocleid
  – Masseter
  – Genioglossus

Practical strategy of Neurography in ALS

• Neurography MCS (bilaterally)
  – n.medianus
  – n.ulnaris (also including supraclavicular stimulation)
  – n.peroneus
  – n.tibialis

• Neurography SCS (bilaterally)
  – n.suralis
  – n.radialis

• MEP
  – upper and lower extremity

Multifocal motor neuropathy with conduction block (MMN)

MMN - Clinical features 1

• Slowly progressive weakness distributed over individual peripheral nerves rather than myotomes (in ALS the distribution follows spinal myotomes)
• Progression usually slow over years
• Weakness is often distal, rarely proximal

MMN - Clinical features 2

• Muscle atrophy of weak muscles is less pronounced than would be expected (weakness is partly due to conduction block)
• Fasciculations, cramps and myokymia
• Although MMN is predominantly a motor neuropathy, there may be mild sensory symptoms and findings

MMN - Clinical features 3

• No signs of upper motor neuron lesion
• Rarely involvement of cranial nerves
• Diaphragm is rarely affected
• Clinically MMN and ALS present usually differently
• Sometimes be difficult to distinguish MMN from ALS clinically
MMN - Etiology

- Unknown, possibly an autoimmune reaction against gangliosides (GM₁)

MMN - Expected abnormal EMG findings

- Subacute or chronic neurogenic EMG findings in muscles innervated by different nerves
- Weakness and EMG findings are distributed according to peripheral nerves rather than myotomes

MMN - Expected abnormal neurography

- Motor nerves show conduction blocks (amplitude and area decay, reduced number of F-waves)
- Often reduced M wave amplitudes
- Motor conduction velocity may be reduced

MMN - Expected normal findings

- Sensory nerve conduction studies
- Central motor conduction time normal

Post-polio conditions

- Post-polio syndrome - PPS
- Post-polio muscular atrophy - PPMA

Post-polio muscle dysfunction clinical criteria

- History of paralytic polio
- Functional stability for 15 years
- New (and/or)
  - Weakness
  - Atrophy
  - Pain
  - Fatigue
- Neurological exam = lower motor neurone
- No other disorders to explain symptoms
Post-polio syndrome - etiology for deterioration in n-m function

- disuse
- overuse
- weight gain
- chronic weakness

Post-polio syndrome - causes for deterioration in n-m function

- reactivated virus
- loss of motor units
- excessive metabolic demand
- muscle fibre defect

Schematic fig of reinnervation

2 normal motor units grouping but no extension outside borders

Macro EMG signal from the entire motor unit

Macro MUPs in Tibial anterior muscle

Macro MUPs in patients with acute polio >30 years ago
Change in Macro EMG in patients with polio more than 30 years ago
4 year follow up

Polio - after 1 week

Polio - after 3 months

Polio - after "10 years"

Polio - after "20 years" - PPS
Poor recovery in post polio patients after fatiguing exercise

Controls

More fatigue during exercise

Polio patients

Conclusion

• Nearly all post polio subjects have EMG changes
• If EMG is normal, reconsider the diagnosis
• A ”normal EMG” does not completely exclude a previous polio