THE ROLE OF EMG INVESTIGATIONS IN PPS

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Over 4000 inpatient beds
125,000 inpatient /year
450,000 inpatient / year
• the diagnosis of post polio syndrome is a clinical diagnosis.
• no objective test is available to detect the presence of post polio syndrome

The value of EMG investigations
If EMG investigations are performed appropriately, with a specific purpose in mind, they can be very helpful!!
Electrodiagnostic investigations used in polio patients

- Conventional Needle electromyography (EMG)
- Nerve Conduction Studies
- Macro EMG
- Motor Unit Number Estimation
Needle EMG investigations

diagnostic techniques used to evaluate
structure of a motor unit electrophysiologically
Motor Unit

Motor Neuron

Axon

Muscle fibers

SMUP

Uluğ B.
Motor Neuron Pool

Clinically apparent muscle contraction
Many MUPs from different motor units

Uludağ B.
Amplitude, duration of a MUP: number and size of muscle fibers in the motor unit, synchronicity of their action potentials
Observations in an EMG study

1. at rest

Normally silent

2. with slight contraction

MUPs appear

3. at full effort

interference
EMG findings in the muscles affected by poliomyelitis

What happens to the motor units

• during acute polio
• during recovery period
• long after recovery
**EMG findings**
Denervation potentials at rest

Decreased recruitment
recovery process

Collateral sprouting
Reinnervation
Number of surviving MNs

Ability to form sprouts

Loss of up to 50% of motor neurons
Complete recovery in muscle strength

only a few motor neurons remain
Weakness, progressive atrophy
Surviving motor neurons innervates more muscle fibers than normal.

Motor unit enlarged (up to seven-fold normal size!)
Normal MUP

Increased motor unit size
Increased amplitude and duration of the MUPs

Ertekin C
Right Tibialis anterior
long after recovery

- Continue to have EMG abnormalities....
- always leaves clear abnormalities on subsequent EMG studies

| Loss of motor units | Decreased recruitment  
| Persistance of denervation potentials at rest |
| Increased motor unit size | Increased amplitude and duration of the MUPs |
EMG abnormalities in polio

1. at rest

2. with slight contraction

Active denervation may persist

Large MUPs

3. at full effort

reduced recruitment
EMG studies have no value in detection or exclusion of the presence of PPS.

Symptomatic and asymptomatic muscles have the same findings. No specific EMG abnormality is observed in symptomatic PPS patients.
Diagnostic value of EMG investigations in polio
Diagnostic value of EMG investigations in polio

1. for confirmation of past poliomyelitis involving motor neurons

if EMG findings are normal, the original diagnosis of polio must be revised.

the lack of clear evidence for previous denervation after extensive electrodiagnostic testing is a valid means for excluding the diagnosis of postpolio syndrome

(Bromberg and Waring. Arch Phys Med Rehabil 1991)
1. Prior paralytic poliomyelitis with evidence of motor neuron loss. This is confirmed by history of the acute paralytic illness, signs of residual weakness and atrophy of muscles on neuromuscular examination, and signs of motor neuron loss on EMG. Rarely, people had subtle paralytic polio where there was no obvious deficit. In such cases, prior polio should be confirmed with an EMG study rather than a reported history of nonparalytic polio.
2. To detect motor neuron involvement in muscles which had \textbf{clinically recovered}, but also in muscles that were never thought to be affected.

Loss of up to 50% of motor neurons: complete recovery
\textbf{normal} muscle strength abnormalities in EMG
Objective: To evaluate EMG abnormalities and late progressive symptoms in limbs reported as non-affected by polio survivors, in order to determine the prevalence of sub-clinical motor neuron involvement in those fulfilling criteria for PPS comparing to those without such symptoms.

Methods: Clinical and EMG findings of 464 limbs in 116 polio survivors were retrospectively analyzed. Affection of the limbs by polio was classified based on the patient’s self-report on remote weakness during the acute phase of poliomyelitis, muscle strength measured by manual muscle testing and four-limb needle EMG.
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Count</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td><strong>Affected</strong></td>
<td>history of remote weakness</td>
<td>171/464</td>
<td>(37%)</td>
</tr>
<tr>
<td></td>
<td>normal or decreased strength/atrophy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EMG evidence of prior polio</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-affected</strong></td>
<td>no history of remote weakness</td>
<td>293/464</td>
<td>(63%)</td>
</tr>
<tr>
<td></td>
<td>normal strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>normal EMG</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-clinically involved</strong></td>
<td>no history of remote weakness, normal/slightly decreased strength</td>
<td>122/293</td>
<td>(42%)</td>
</tr>
<tr>
<td></td>
<td>EMG evidence of prior polio</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diagnosis of PPS</strong></td>
<td>Patients’s self report</td>
<td>76/116</td>
<td>(65.5%)</td>
</tr>
<tr>
<td></td>
<td>March of Dimmes criteria</td>
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Table 1: The associations between the presence of PPS and sub-clinical involvement

<table>
<thead>
<tr>
<th></th>
<th>Subclinical involvement</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>PPS</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>99</td>
<td>87</td>
</tr>
<tr>
<td>%</td>
<td>53%</td>
<td>47%*</td>
</tr>
<tr>
<td>no</td>
<td>72</td>
<td>35</td>
</tr>
<tr>
<td>%</td>
<td>67%</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>171</td>
<td>122</td>
</tr>
<tr>
<td>%</td>
<td>58%</td>
<td>42%</td>
</tr>
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</table>
Patients diagnosed as PPS had reported new weakness in 114 out of 304 limbs (38%).

Table 2: Distribution of the limbs reported as having developed new weakness in PPS patients (n=114)

<table>
<thead>
<tr>
<th></th>
<th>Affected limb</th>
<th>Sub-clinical limb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Normal strength</td>
<td>Slightly decreased strength</td>
</tr>
<tr>
<td>n</td>
<td>76</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>%</td>
<td>66.5%</td>
<td>24.5%</td>
<td>9%</td>
</tr>
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</table>

(74%)
The results of the study showed;

- high prevalence of subclinical involvement in patients with a history of paralytic poliomyelitis.

- prevalence of sub-clinical involvement is even higher in the patients diagnosed as PPS.

- polio survivors may report new muscle weakness in the sub-clinically involved muscles with apparently normal strength.
Conclusion of this study

• Needle EMG studies, are the most reasonable standard of determining the muscles affected by polio virus infection.

• Detection of the presence of subclinically involved muscles would be important in determining management strategies in PPS, because new muscle weakness may develop in apparently non-affected, sub-clinically involved muscles.

• Extensive needle EMG testing using a standard sampling technique should be performed at least once in all polio survivors.

• the emphasis on a history of paralytic polio as part of the PPS criteria can be misleading and confusing, thus the diagnostic criteria for post-polio syndrome should be modified.
Diagnostic value of EMG investigations in polio

3. for exclusion of other conditions that may explain the new symptoms of post polio syndrome (peripheral neuropathy, radiculopathy, myelopathy)

Part of PPS definition!

4. to find concominant nerve or muscle disorders (entrapment, radiculopathy)
Case

- 34 years old man with a history of poliomyelitis in his right lower limb
- Dropping of his right forefoot
- Pain in his right lower limb
- Noticed 3 months ago.
Case

- Admitted to a local hospital
- Referred to an EMG lab
  - Radiculopathy?
- Electromyographer stopped doing EMG, when he learned that the patient had polio!!
  
  «your diagnosis should be PPS; EMG is not necessary»
Neurological Examination

- Positive sciatic nerve stretch
- Decreased sensitivity to touch in the L5 and S1 dermatomes
- No upper motor neuron sign
## Degree of paresis in muscle groups
(Manual Muscle Testing-right lower limb)

<table>
<thead>
<tr>
<th>Muscle groups</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Hip flexors</td>
<td>3</td>
</tr>
<tr>
<td>Hip abductors</td>
<td>3</td>
</tr>
<tr>
<td>Knee extensors</td>
<td>3</td>
</tr>
<tr>
<td><strong>Ankle dorsiflexors</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>Ankle plantar flexors</td>
<td>5</td>
</tr>
</tbody>
</table>
### Needle EMG findings

<table>
<thead>
<tr>
<th>Muscle groups</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Iliopsoas</td>
<td>Prior polio</td>
</tr>
<tr>
<td></td>
<td>Chronic denervation and reinnervation</td>
</tr>
<tr>
<td>Right Vastus Lateralis</td>
<td>Prior polio</td>
</tr>
<tr>
<td></td>
<td>Chronic denervation and reinnervation</td>
</tr>
<tr>
<td>Right Tibialis Anterior</td>
<td>Prior polio</td>
</tr>
<tr>
<td></td>
<td>Massive denervation potentials</td>
</tr>
<tr>
<td></td>
<td>Acute, severe partial denervation</td>
</tr>
<tr>
<td>Right Gastrocnemious</td>
<td>Normal</td>
</tr>
</tbody>
</table>

**Nerve conduction studies: Normal**
spinal nerve root compression caused by a sequestered lumbar intervertebral disc that migrated caudally away from the L4-5 interspace of origin.
Diagnostic value of EMG investigations in PPS

1. No value for detection or exclusion of the presence of PPS
2. Confirmation or exclusion of motor neuron involvement compatible with previous polio
3. Detection of motor neuron involvement in the muscles considered unaffected (subclinical polio)
4. Determination or exclusion of other conditions that may explain the new symptoms of PPS
5. Detection of concomitant nerve or muscle disorders
<table>
<thead>
<tr>
<th><strong>Clinical utility of EMG studies in PPS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a patient with a history of polio with obvious atrophic paralysis</strong></td>
</tr>
<tr>
<td>EMG unnecessary</td>
</tr>
<tr>
<td>To confirm past poliomyelitis</td>
</tr>
<tr>
<td><strong>a patient with a vogue history of polio misdiagnosed with polio</strong></td>
</tr>
<tr>
<td>EMG helpful</td>
</tr>
<tr>
<td>To rule out poliomyelitis</td>
</tr>
</tbody>
</table>
Prof. Dr. Erik Stalberg
Sweden

Prof. Dr. Cumhur Ertekin
Turkey
Future research

• Relations with the symptoms of PPS.

• **Diagnostic value of macro EMG** (Grimby G, Stalberg E, Sandberg A, Sunnerhagen KS. An 8-year longitudinal study of muscle strength, muscle fiber size, and dynamic electromyogram in individuals with late polio. *Muscle Nerve* 1998)

• **Changes in motor units over time or in response to treatment.**