Generalized seizures, generalized spike-waves and other things

Charles Deacon MD FRCPC
Centre Hospitalier Universitaire de Sherbrooke
Objectives

• Give an overview of generalized EEG discharges and seizures
• Be able to better distinguish generalized EEG discharges from non-epileptiform discharges including triphasic waves
• Become aware of the widely variable clinical and EEG presentations of generalized nonconvulsive status epilepticus and understand some of the limitations of the EEG in this setting
Disclosure

- Nothing to declare
EEG interpretation

To avoid overdiagnosis, always analyse an EEG phenomenon in the following order:

- Artifact
- Normal phenomena or variant
- Non epileptiform abnormality
- Epileptiform abnormality
Generalized epileptiform discharges

- Spike-wave complexe and polyspike-wave complexe
  - Bilaterally synchronous
  - 2.5-4 Hz
  - Begin and end abruptly
  - Repetition rate slows during long paroxysms
  - Maximum usually F4, F3
  - Best seen on referential montages
Spike-wave and polyspike-wave
Bipolar montage
Coronal montage
Spike-wave: incomplete form
Spike-wave asymmetries with generalized epilepsies

- Maximal expression over one hemisphere
- Shifting of such asymmetry on the EEG
- « Focal » spike-wave or fragments
- Frequent finding in juvenile myoclonic epilepsy
  - 17-73%
- Probably no effect on response to treatment in JME
EEG fragments of spike-waves
Focal expression of a spike-wave
Varying field of spike-waves
Slow spike-wave complexes: Lennox-Gastaut (45 yo)
Lennox-Gastaut
Polyspikes

**FIG. 5-20. Runs of polyspikes.** 21 years. Sleep recording. A burst of bisynchronous spikes at 10–25 Hz is an epileptiform pattern associated with primary generalized epilepsy. Other aspects of the Lennox-Gastaut syndrome may be present (30, 31). This pattern may appear in patients of any age with tonic or absence seizures. Calibration signal 1 sec, 70\(\mu\)V.
Generalized seizures
Absence seizure: 3 Hz SW
Thalamocortical circuit in absence seizures
Functional MRI : IGE

Gotman J et al. PNAS 2005;102:15236-15240
Generalized paroxysmal fast activity

: tonic seizure

FIG. 6-32. Symmetrical “paroxysmal fast activity” and asymmetrical tonic seizure. 32 years. From light sleep and a background of low voltage beta activity, sequential polyspikes suddenly appear, initially associated with a diffuse V-wave (left). This phenomenon is also termed “generalized paroxysmal fast activity” (31) and “runs of rapid spikes” (43). Although such polyspikes appear symmetrical in onset, maximum expression, and offset, the clinical association contained many asymmetries: right arm elevation with elbow flexion, leftward cephalic deviation, and left arm flaccidity. Calibration signal 1 sec, 70µV.
A « generalized » normal EEG variant
N wave
N wave

Spike-wave

<table>
<thead>
<tr>
<th></th>
<th>N waves N=63 (%)</th>
<th>Spike-waves N=52 (%)</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>Preceded by 14 hz positive spikes</td>
<td>41 (65)</td>
<td>0 (0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Preceded by 6 hz positive spikes</td>
<td>9 (14)</td>
<td>0 (0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Any preceding positive spikes</td>
<td>45 (71)</td>
<td>0 (0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fluctuating amplitude of slow wave (referential)</td>
<td>29 (48)*</td>
<td>5 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Multiple phase reversals of slow wave (bipolar)</td>
<td>41 (66)</td>
<td>5 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Maximum of negative spike on frontal leads (referential)</td>
<td>3 (5)</td>
<td>27 (52)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean amplitude of negative spike</td>
<td>55 uV , range of 20-110</td>
<td>123 uV ,range of 30-400</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

N complex: bipolar montage
N complexes: « Call me anything but a spike-waves »

- Rare normal variant closely associated with 14-6 positive spikes
  - Harmonic relation (2-3 Hz)
- Children or teenagers
- Light sleep exclusively
- Need to be recognized to avoid misdiagnosis with generalized spike-waves
EEG in generalized nonconvulsive status epilepticus (NCSE)

- Generic term for many different conditions
  - Absence status epilepticus
  - Generalized discharges with coma in ICU
  - Subtle status epilepticus evolving from convulsive status epilepticus
  - Boundary states: «spiky» triphasic waves with metabolic encephalopathy or GPEDs
Working definition of NCSE

1. Repetitive generalized/focal spikes, polyspikes, sharp waves or SW of more than 2.5 Hz
2. Above with <2.5 Hz, clinical and EEG improvement with AEDs (BZP)
3. Above with <2.5 Hz, focal ictal phenomena (facial twitching...)
4. Rythmic waves at >0.5 Hz with incrementing onset, evolution in pattern/location, decrementing termination or post-PED background slowing

70 yo female patient

- Found at home with altered consciousness
- Neurological exam:
  - Afebrile,
  - Stupor
  - Multi-focal myoclonus
  - No focal signs
- CBC, glucose and electrolytes: N
EEG
What to do next?

- A) Ativan 2 mg IV during EEG
- B) Dilantin loading 18 mg/kg IV stat
- C) Internal medicine consultation
- D) Intubate and give IV propofol
Triphasic waves and metabolic encephalopathy, hepatic cirrhosis
Triphasic waves

- 3 phases of increasing duration
- Total duration 150-500 msec, 1-2.5 hz
- Large amplitude positive wave preceded and followed by smaller negative waves
- Slow background with delta activity
- Most common with hepatic, renal or septic encephalopathy
- Usually not associated seizure activity or seizures
**Electrographic differentiating features between patients with TWs (N=71) and patients with GNCSE (N=13)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>TWs group</th>
<th>GNCSE group</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td><strong>Mean frequency of discharges, Hz +/- 2 SD</strong></td>
<td>1.8 +/- 0.8</td>
<td>2.4 +/- 1.0</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td><strong>Phase two lag (%)</strong></td>
<td>29 (40.8)</td>
<td>0 (0)</td>
<td>0.01</td>
</tr>
<tr>
<td>Maximal involvement of frontopolar electrode (%)</td>
<td>25 (35.2)</td>
<td>2 (15.4)</td>
<td>0.279 (NS)</td>
</tr>
<tr>
<td>Extraspike component (%)</td>
<td>0 (0)</td>
<td>9 (69.0)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td><strong>Background slowing (%)</strong></td>
<td>65 (91.5)</td>
<td>2 (15.4)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Amplitude predominance of phase two (%)</td>
<td>29 (40.8)</td>
<td>0 (0)</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Phase 1 duration, msec +/- 2 SD</strong></td>
<td>98.3 +/- 27.4</td>
<td>54.6 +/- 50.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Increased amount of discharges with stimulation (%)</td>
<td>25 (51.0*)</td>
<td>0 (0)</td>
<td>0.0022</td>
</tr>
</tbody>
</table>

* The proportion of patients where stimulation was performed.

TW: increasing amount with stimulation
35 yo male

- Epilepsy since childhood
- Confusion, lethargy
- Brought in emergency by his family
- Vitals are normal, facial twitching
- EEG
EEG
Next step?

- A) Head CT
- B) Epiject (valproate) 500 mg IV
- C) Phenytoin 18 mg/Kg IV
- D) Lorazepam 2 mg IV
- E) Internal medicine consultation
Post-Ativan 2 mg: clinical and EEG improvement
**Absence status : EEG**

- Generalized spike-waves or polyspike-waves of variable frequency (2.5-3 Hz)

- Clinical and EEG improvement following benzodiazepines
EEG : Absence Status with polyspikes
70 yo male: Anoxic encephalopathy and myoclonus
GPEDs with background suppression
GPEDs: Generalized periodic epileptiform discharges

- Surface negative discharges with spike, sharp, polyspikes or slow wave complexes
- Mean duration of 200 msec
- 0.2-3 Hz
- Persistence (at least 10 minutes)
- Static evolution with only minor variability
- In coma following cardiac arrest: poor neurological outcome
**Conclusion**

- "Focal expression" of generalized discharges is frequent on the EEG in patients with generalized epilepsies.
- In many cases, triphasic waves associated with metabolic encephalopathy can be distinguished from GNCSE.
- The EEG presentations of GNCSE are variable and need to be interpreted with the clinical context.
- N complexes associated with 14-6 Hz positive spikes are rare but need to be recognized by electroencephalographers.
References