The EEG in generalized epilepsy

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I have no financial relationships to disclose that are relative to the content of my presentation.
Self assessment questions
Q1- What is most likely for the EEG above

A. It is indicative of occipital lobe epilepsy
B. It indicates abnormal cognitive function
C. It may be seen in childhood absence epilepsy
D. It is an interictal finding in juvenile myoclonic epilepsy
Q2- What is not true for the EEG above

A. It is indicative of focal epilepsy
B. It could be consistent with generalized epilepsy
C. The discharges may be “fragments” of generalized spike-and-wave discharges
D. This could be an interictal finding in juvenile myoclonic epilepsy
Q3- What is most likely for the EEG above

A. The affected child has normal intelligence
B. The affected child likely has neurological abnormalities and tonic seizures
C. The discharge is always associated with a clinical seizure
D. The EEG is normal
Q4- What is most true of the EEG above

A. The associated epilepsy is likely to remit at puberty
B. The discharge may be associated with a myoclonic seizure
C. The discharge is likely associated with a typical absence seizure
D. This is a normal variant
Learning Objectives

- to identify generalized epileptiform abnormalities
- to recognize generalized ictal patterns
- to distinguish idiopathic from symptomatic generalized epilepsies
Epileptiform discharges in generalized epilepsies

- Usually not totally generalized - tend to have a frontal predominance
- Shifting asymmetries acceptable
- Focal discharges acceptable if shifting between the two sides
- The spike-and-wave complex is the hallmark of generalized epilepsies
Childhood Absence Epilepsy- “interictal”

- Interictal EEG background usually normal
- Single or brief serial bilateral spike-and-wave discharges may be seen (with variable field)
- “Fragments” of generalized discharges may be seen- can be focal left or right (shifting) frontocentral spikes/sharp waves or spike-and-slow-wave complexes
- Some children have 3 Hz OIRDA
Childhood Absence Epilepsy- ictal

- Generalized 2.5-4Hz bilaterally synchronous and symmetrical spike-and-wave discharge, with bifrontal predominance- stable course- nonprogressive, except that frequency drops very slightly between onset and termination
- Abrupt onset; abrupt termination
- Seizures reliably precipitated by hyperventilation in the untreated child
Generalized Absence Seizures

- Commonly end at a frequency slightly slower than at onset
- May have shifting lateralized onset
- May become more irregular with increasing age
- Unusual variants exist
  - Fast rhythms
  - Absence of spike component
- Atypical absence seizures usually <2.5 Hz. They may be irregular and asymmetrical
RIGHT HEMISPHERE ONSET OF GENERALIZED SPIKE WAVES

AWAKE

Fp¹ - F₃
F₃ - C₃
C₃ - P₃
P₃ - O₁
Fp² - F₄
F₄ - C₄
C₄ - P₄
P₄ - O₂

9 yrs

300 µV

1 SEC
ABSENCE STATUS

Fp¹ - F₃  
F₃ - C₃  
C₃ - P₃  
P₃ - O₁  
Fp² - F₄  
F₄ - C₄  
C₄ - P₄  
P₄ - O₂  

11 yrs

300 µV

1 SEC
Juvenile Myoclonic Epilepsy

- Background activity is usually normal.
- Rapid generalized spike-and-wave and polyspike-and-wave activity (4-6 Hz) is seen interictally and with generalized myoclonic seizures.
- Discharges are more likely just after arousal from sleep, and with sleep deprivation.
Juvenile Myoclonic Epilepsy

- Some focality is acceptable- Focal slow waves, spikes, and sharp waves and focal onset of the generalized discharge were present in 36.7% of EEGs in one series. In more than half of the patients, at least one EEG showed focal abnormalities.

- 3 Hz spike-and-wave discharges are seen in conjunction with absence seizures (noted in ~30%)
Lennox Gastaut Syndrome

- Slow posterior background. May include focal slow activity
- Slow (2 Hz) generalized spike-and-wave complexes; may have asymmetries
- Paroxysmal fast activity in sleep.
Generalized tonic seizures

- Most common with Lennox-Gastaut syndrome
- Three patterns at onset:
  - Generalized attenuation
  - 10 Hz recruiting rhythm
  - High frequency fast activity
- Slower frequencies become gradually intermixed
Generalized Tonic seizures

Different patterns were described:

- Generalized low voltage fast activity
- Generalized voltage attenuation, sometimes preceded by a “transitional” high voltage sharp wave
- Generalized 10 Hz “recruiting rhythm”

Slower frequencies become gradually intermixed
Doose syndrome

- 2-3 Hz spike-and-wave, polyspike-and-wave discharges
- Generalized polyspike-and-wave discharge followed by attenuation in association with myoclonic atonic seizures
Generalized Epilepsy- Idiopathic vs Symptomatic

- Posterior background
- Focal abnormalities
- Frequency of spike-and-wave discharges
- Specific seizure types suggest symptomatic/cryptogenic (secondary) generalized epilepsy:
  - Atypical absence
  - Tonic seizures
  - Atonic seizures
Interictal EEG

**Idiopathic**
- Normal background
- No focal slow activity
- Frequency of spike-and-wave discharges >2.5 Hz in waking
- No paroxysmal fast activity

**Symptomatic**
- Slow background
- May have focal slow waves
- Frequency of spike-and-wave discharges <2.5 Hz in waking
- May have multifocal epileptiform discharges
- Paroxysmal fast activity in sleep
Generalized epilepsy

- **Idiopathic**
  - 2.5-4 Hz SW
  - 4-6 Hz SW (JME)
  - 10-12 Hz rhythms

- **Symptomatic**
  - Hypsarrhythmia
  - Slow SW
  - Paroxysmal fast activity
  - Multifocal S or SW
Best timing of an EEG

- **JME**
  - Best in the morning after arousal from a nap in a sleep deprived individual

- In general, in a patient who has had normal EEG, but where the diagnosis of epilepsy is very likely
  - Early postictal recording: seizures activate spikes- postictal recordings may show both epileptiform activity and slow activity
### EEG abnormalities with 3 EEG protocols among 85 patients

(DI-EEG = EEG during drug-induced sleep, r-EEG = routine EEG; SD-EEG = EEG after sleep deprivation). [Leach et, JNNP 2006](#)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>n (%)</th>
<th>Sensitivity</th>
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<tbody>
<tr>
<td><strong>Generalized spike-and-wave</strong></td>
<td>36 (43%)</td>
<td></td>
</tr>
<tr>
<td>Yield SD-EEG</td>
<td>33</td>
<td>0.92</td>
</tr>
<tr>
<td>Yield DI-EEG</td>
<td>21</td>
<td>0.58</td>
</tr>
<tr>
<td>Yield r-EEG</td>
<td>16</td>
<td>0.44</td>
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<tr>
<td><strong>Focal discharges</strong></td>
<td>15 (18%)</td>
<td></td>
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<tr>
<td>Yield SD-EEG</td>
<td>11</td>
<td>0.73</td>
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<tr>
<td>Yield DI-EEG</td>
<td>4</td>
<td>0.27</td>
</tr>
<tr>
<td>Yield r-EEG</td>
<td>6</td>
<td>0.40</td>
</tr>
<tr>
<td><strong>3 normal EEGs</strong></td>
<td>33 (39%)</td>
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Morning vs pm EEG

- 29 consecutive patients with JME
- 5 were untreated, 9 were treated with valproate, 8 with lamotrigine, 6 with levetiracetam and 1 with valproate plus phenobarbital.
- Two routine consecutive interictal EEG recordings were performed at 9 a.m. and at 3 p.m., respectively, while the subject was awake, on the same day after regular nocturnal sleep at own home.
- Morning EEG showed GEDs (i.e., generalized polyspike-and-waves, photoparoxysmal response, or both) in 20/29 patients.
  - In 15, the afternoon recording was normal ($p \leq 0.001$).
  - Striking reduction of GEDs in 3 of remaining 5 patients.
- Nine/29 patients had both morning and afternoon EEG recording normal.
Secondary bilateral synchrony

- Bilaterally synchronous discharge which originates focally from one brain region
- Usually mesial or parasagittal origin
- Common with frontal and parietal foci
Evidence for secondary bilateral synchrony

- Asymmetry of spike-and-wave discharges
- Isolated focal discharges
- Focal discharges above sometimes preceding generalized SW discharges
- Focal slow activity or attenuation
- Consistent lead on one side
Photosensitivity

- Most likely with active eye closure at onset of stimulation, then eyes closed, then eyes open
- Most common at flash rates of 12-25 Hz
- Sustained beyond end of stimulation versus not sustained
- More significant if generalized
Photosensitivity in adults with and without epilepsy

Photosensitivity was found in

- 14/1940 (0.72%) newly recruited entrants for training as pilots; one developed seizure during EEG recording
- 1/160 (0.62%) individuals working on radars for prolonged periods
- 30/1000 (3%) with known epilepsy
Japanese survey

- 652 with photosensitivity
- 6% without epilepsy
- 26% pure photosensitive seizures
- 63% photosensitive and spontaneous seizures
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