Abnormal EEG in Infants and Children

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Disclosure

- Relevant Financial Relationships
  - None

- Off Label Use
  - None
Learning Objectives

- Review patterns of abnormal EEGs in infants and children and potential etiologies
- Discuss epileptiform EEG patterns in infants and children and the accompanying seizure types
Mild EEG Abnormalities

- Immature pattern for age
- Excessive multifocal sharp transients (neonates)
Excessive Multifocal Sharp Waves

M age: 10 days

Neonatal seizures

70 µV

1 sec
Significant EEG Abnormalities

- Positive Rolandic Sharp Waves (preterm)
- Persistent asymmetry / asynchrony
- Suppression
- Epileptiform discharges
Positive Rolandic Sharp Waves

**Age:** 37 wk CA

- Fp₁-F₃
- F₃-C₃
- C₃-P₃
- P₃-O₁

**Scale:**
- 100 µV
- 1 sec
Intraventricular Hemorrhage
Asymmetry of EEG in a Neonate
Neonatal Stroke
Suppression and Seizure Discharges

M age: 3 days

FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2

Perinatal hypoxia
Neonatal seizures

1 sec 50 μV
Types of Disorders

- Metabolic
- Biochemical
- Degenerative
- Dysgenic
- Inflammatory
- Tumors
- Trauma
- Vascular
Metabolic

- Hypoglycemia
- Hypocalcemia
- Hyponatremia
Hypoglycemia

Prominent hyperventilation response
Effect of Glucose on Hyperventilation Response

Patient last ate 24 hours ago  After 50 g of glucose
Hypoglycemia

- Prominent hyperventilation response
- Slowing
Effect of Hypoglycemia on EEG

Blood sugar = 26 mg %

Blood sugar = 125 mg %

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

10 M Unresponsive Alert
Hypocalcemia

- Slowing
- Photoparoxysmal response
- Epileptiform abnormalities
Hypocalcemia

Ca = 6.1 mg/dL
Photoparoxysmal Response with Hypocalcemia

Hypoparathyroidism
Recent onset of generalized seizures

Ca = 4.3 mg
Ca = 9.2 mg

16 F
15 Hz

No further seizures
Hyponatremia

- Diffuse Slowing
- Triphasic waves
Polymorphic Delta Slowing

Water intoxication syndrome: Na = 112 mEq/L
Biochemical Disorders

- Slowing
- Epileptiform abnormalities
Degenerative Disorders
Diffuse Disorders

- Gray matter
  - Epileptiform activity
- White matter
  - Delta slowing
Progressive Familial Myoclonic Epilepsy
Metachromatic Leukodystrophy
Dysgenetic Conditions
AKA Neurocutaneous Disorders
Sturge - Weber

M age: 6 mo

FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2

Left facial nevus calcification and hemiatrophy – left cerebral hemisphere
Recorded Seizure in Patient with Tuberous Sclerosis

Age: 2 yr

Eyes blinking and deviated to left
Large right frontal-parietal tuber

100 µV
1 sec
Inflammatory Disorders
Inflammatory Disorders

- Meningitis
- Encephalitis
- Abscess
- SSPE
Encephalitis

Several-day Hx of fever, headache, and progressive obtundation
Recorded Sz in a Patient with Encephalitis

Jerking of eyes to the right with generalized tonic posturing
Right Frontal Abscess

9-year-old male

[Graph showing EEG readings from various scalp locations: Fp1-F3, Fp1-C3, C3-P3, P3-O1, Fp2-F4, F4-C4, C4-P4, P4-O2]
Subacute Sclerosing Panencephalitis – (SSPE)
Tumors

- Greater degree of slowing than adults
- Maximum over the posterior head regions
Posterior Fossa Tumor with Posterior Rhythmic Slowing

Right cerebellar astrocytoma

Age: 6 yrs

Headache, nausea, vomiting, papilledema

5 months post surgery

Asymptomatic
Head Trauma
Head Trauma

- Slowing
- Asymmetry
- Epileptiform abnormalities
Posterior Slowing After Head Trauma

Alert, normal neurologic exam

7 M 1-Day Post Head Injury

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

1 sec  50 µV
Severe Head Injury with Recovery

Severe head injury
Comatose

Minor motor and speech deficit
1 sec

50 μV
Vascular Disorders
Vascular Disorders

- Infarcts
- Hemorrhage
- Vascular Malformations
PLEDS in a Young Child Associated with Clonic Movements of the Right Arm

Sudden onset of focal sided seizures and obtundation. Thought to be secondary to thrombosis of a branch of the left middle cerebral artery.
Abnormal EEG. Is this a …?
- Grey matter disorder
- White matter disorder
- Vascular disorder
- Structural disorder
- Metabolic disorder

Watch for:
- Asymmetry
- Slowing
- Suppression
Which Type of Degenerative Disorder is More Commonly Associated with Epileptiform Activity on the EEG?

- A: White Matter
- B: Gray Matter
Epileptiform Patterns
Epileptiform Discharges

- $F_{P1}-F_7$
- $F_7-T_3$
- $T_3-T_5$
- $T_5-O_1$
- $T_3-F_{P1}$
- $T_4-F_{P2}$
- $F_{P1}-F_3$
- $F_{P2}-F_{P4}$

Sharp wave (>70 msec)

Spike (<70 msec)

- $F_{P1}-A_1$
- $F_{P2}-A_2$
- $F_3-A_1$
- $F_4-A_2$

Spike and wave

1 sec

100 $\mu$V
Ictal and Interictal Discharges
Seizure Discharges in Infants

- Subclinical electrographic discharges
- Prolonged
- Variable morphology
- Rhythmic activity
- Focal or multifocal
Electrographic Seizure Discharge in an Infant

M age: 8 days

No clinical accompaniment
Bilateral Independent Seizure Discharges in an Infant with Neonatal Seizures

Age: 6 days

- Microcephaly, Jaundice
- Congenital defects
Neonatal Seizure
Hypsarrhythmia

- High amplitude poorly organized background
- Multifocal epileptiform discharges
- Generalized electrodecrements
- Epileptic spasms
- West syndrome
Hypsarrhythmia

Perinatal anoxia

Infantile spasms since 3 mo of age
Hypsarrhythmia
Epileptic (Infantile) Spasms
Generalized Patterns

- 3 Hz spike and wave
- Atypical spike and wave
- Slow (2-2.5 Hz) spike and wave
- Paroxysmal fast
3 Hz Spike and Wave

- Absence seizures
- 3 -15 yr of age
- Increased with hyperventilation
- Background EEG normal
Atypical Spike and Wave

- Multiple generalized seizures
- Juvenile Myoclonic Epilepsy
  - Absence 7-13 yrs (if atyp. Spw higher risk for JME)
  - Myoclonic jerks 12-18 yrs
  - Generalized tonic clonic sz. 13-20 yrs
- 3.5-6 Hz generalized spike and polyspike and wave – faster frequency
- Photoparoxysmal response
- Background EEG normal
Generalized Atypical Spike Wave
Atypical Spike and Wave Discharges

21-year-old female

FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
Slow Spike and Wave (<2 Hz)

- Lennox-Gastaut Syndrome – anterior dominant
- Frequent seizures of multiple types
- Mental retardation
- 2-6 years
- Background EEG abnormal
Paroxysmal Fast Discharge

- Trains of repetitive spikes
- 8-20 Hz
- Tonic / Atonic seizures
- Tonic stiffening / drop attacks
Paroxysmal Fast Activity with Tonic Seizure

7-year-old male

Tonic stiffening of the body

100 μV
Focal Epilepsy: BECTS (BRE)

- Seizures usually occur out of sleep
  - Tingling hand / face
  - Motor speech arrest
  - Excessive salivation
  - Clonic movements of hand / face
  - Or secondary generalized TC seizure

- 3-13 yrs (peak 9-10 yrs)

- Dramatic activation of centro-temporal spike and waves during sleep

- 90% are otherwise normal
Centro-temporal Spikes
Trains of Centro-temporal SPW
Evolution to a GTC seizure
Electrical Status Epilepticus During Slow Wave Sleep (ESES)

- Nearly continuous activation that
  - Began with sleep onset
  - Continued throughout the night
  - Resolved upon awakening
  - No clinical correlate
- Normal sleep patterns
**ESES**

- Patry: SWI 85-100%
  - SWI = (minutes of SW abnormalities x 100) / TOTAL MINUTES NREM SLEEP

- ILAE: “Significant activation of epileptiform discharges in sleep”

- CSWS vs LKS: potentially treatable causes of regression in children
Continuous Spike Wave of Sleep (CSWS)

- Age of onset: variable
- Global regression: language, temporo-spatial, memory
  - Language: expressive aphasia, poor lexical and syntactic skills, comprehension spared
- Behavior: hyperactivity, aggressiveness
- Motor deficits:
- 80% present with seizures
CSWS EEG

- Awake: focal, multifocal, diffuse epileptiform discharges
- Fronto-temporal or fronto-central predominance
- Dramatic activation in sleep
Landau Kleffner-Syndrome (LKS)

- Epileptic syndrome
- **Language regression**: progressive acquired auditory agnosia
- **Behavior**: irritability, hyperkinesia, ADD, autistic-like behavior
- **Epilepsy**: rare, easily treated, nocturnal
- **Etiology**: unknown, development and language is normal prior to LKS
- No abnormalities on neuroimaging
LKS EEG

- Awake: focal, multifocal, diffuse epileptiform discharges, may be normal
- Focal abnormalities, postero-temporal
- Sleep: activation of discharges, maximal centro-temporal with diffuse spread
LKS EEG
Summary

- **3 Hz**: absence seizure: CAE
- **Atypical SW**: generalized seizure, JME
- **Slow SW & paroxysmal fast**: generalized seizure, LGS
- **Hypsarrhythmia**: epileptic spasms
- **C-T spikes**: BRE
- **ESES**: LKS / CSWS
What interictal pattern is most likely to be seen with Lennox Gastaut Syndrome

A: 3 Hz spike and wave

B: Slow spike and wave

C: Atypical spike and wave
Generalized 3 Hz SW is a Typical Ictal Pattern During what Sz type?

- Myoclonic
- Generalized Tonic Clonic
- Absence
- Tonic
Focal Spikes and Sharp Waves are seen over which area in Benign Rolandic Epilepsy

- Frontal
- Centro – temporal
- Parietal
- Occipital