EEG patterns in Encephalopathy

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Scope

• Diffuse encephalopathy
• EEG in specific encephalopathies
• Encephalitides & degenerative encephalopathies

Diffuse encephalopathy

• Common
• Clinical varieties
• Causes
  – Metabolic
  – Septic
  – Toxic
  – Anoxic

EEG in adult patients with Diffuse encephalopathy

• General concepts
  – Diffuse or generalized abnormalities
  – The most common = slowing (< 8 Hz)
    • Adult: more frontal (anterior)
    • Children: more occipital (posterior)
  – No specific patterns for any etiologies
  – Serial EEG
    • Diagnosis, prognosis and Rx assessment

EEG patterns in diffuse encephalopathy

• Common pattern
• More severe pattern
• Less common pattern
Common EEG patterns

• Generalized slowing
  – Background slowing
  – Intermittent slowing
  – Continuous slowing

Background slowing: mild severity

Slow posterior basic rhythm

Intermittent slowing: moderate severity

Intermittent central theta

Burst of generalized slowing
FIRDA
(Frontal intermittent rhythmic delta activity)

Occipital delta: OIRDA

Continuous slowing: severe severity
- Polymorphic delta activity (PDA) > 80%
- No posterior dominant background
- No reactivity
- Very severe case: low amplitude delta activity

Continuous generalized slowing

DDX: Diffuse cerebral disturbances (metabolic, toxic, traumatic)
Severe encephalopathy with epileptic

Generalized slowing

Generalized and focal slowing

i.e. brain tumor and increased intracranial pressure

More severe EEG patterns

• Periodic patterns
• Burst-suppression pattern
• Electrocerebral inactivity

Periodic patterns

• Periodicity
• Complex / multiphasic (epileptiform-like)
• Bilateral occurrence
  – Bilateral periodic epileptiform discharges
  • (Bi-PEDs)
  – Generalized periodic epileptiform discharges
  • (GPEDs)
  – NOT Bi-PLEDs (independent)

Generalized periodic pattern
Generalized periodic pattern with myoclonus in anoxic enceph.

Burst-suppression pattern

- Periodic pattern
- Burst period
  - Mixture of sharp & slow waves ~ 1-3 seconds
- Suppression period
  - Activity < 10 µvolt ~ 5-10 seconds
- Common pattern of anoxic encephalopathy
  - DDx: drug & hypothermia

Burst suppression
Burst suppression

- A nearly flat EEG
- Amplitude < 10 µV
- No reactivity

Nearly flat EEG

Electrocerebral inactivity

- Amplitude < 2 µV
- One of brain death confirmation criteria

Isoelectric

Less common EEG patterns

- Alpha coma
- Beta coma
- Spindle coma
- Triphasic wave
Alpha, beta and spindle waves

- Normal or abnormal
- In comatose patients
  - Amplitude
  - Widespread or unusual spatial distribution
  - Near continuous
  - Non-reactive
- Impression: very severe diffuse encephalopathy

Alpha coma (anoxia > others)

Alpha coma

Post arrest day 4th, patient died 2 days later

Beta coma (drug > others)

Spindle coma
Triphasic waves

- Amplitude > 70 µV (200-300 µV)
- Fronto-central predominant
  - Frontally positive sharp transients
- Symmetrical bilaterally synchronous
- Burst of repetitive waves, frequency 1-3 Hz

Why do we call it a “Triphasic wave”?

1 2 3

- Un-reactive
- Anterior-posterior lag
- Not only hepatic encephalopathy
- Adult > children
Triphasic waves

Severity assessment

<table>
<thead>
<tr>
<th>Grade</th>
<th>Characteristics</th>
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EEG in specific encephalopathies

Toxic encephalopathy

- Sedative-hypnotic agents overdose
- Pathognomonic
  - Excessive beta activity over anterior head regions
  - More severe: generalized theta-delta activity
  - Very severe: Suppression-burst & electro-cerebral inactivity
- Better prognosis than other causes
  - A full neurological recovery

Phenobarbital intoxication

3-day later

$\text{Triphasic waves}$

$\text{Severity assessment}$

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$\text{Phenobarbital intoxication}$

$\text{3-day later}$
Mild to moderately severe slowing (Lithium intoxication)

Anoxic encephalopathy
- Evaluate 5-6 hours after cardio-pulmonary arrest
- Severity and prognosis assessment
  - Grade 1: fully recovery
  - Grade 4-5: death or persistent vegetative

Cerebral death
- More important
  - Clinical assessment: brainstem function
  - Exclude potential reversible factors affecting the brain
- Other assessment tools
  - Blood flow studies
- EEG
  - Amplitude < 2 µV lasting at least 30 minutes
- 2nd assessment
  - Adult 6-12 hours later
  - Children 24-48 hours later

Summary EEG in diffuse encephalopathy
- Diffuse or generalized abnormalities
- The most common = slowing (< 8 Hz)
  - Adult: more frontal (anterior)
  - Children: more occipital (posterior)
- No specific patterns for any etiologies
- Serial EEG
  - Diagnosis: DDX with seizures
  - Prognosis
  - Rx assessment

Introduction
- Viral encephalitis
  - Herpes simplex encephalitis
  - Subacute sclerosing panencephalitis
- Creutzfeld-Jakob disease
- Degenerative encephalopathies
  - White matter disease
  - Cortical gray matter disease
  - Huntington’s disease
  - Infratentorial lesion

EEG in adult patients with
Encephalitides & degenerative encephalopathies
Encephalitides & Degenerative encephalopathies

• Common

• Clinical diagnosis > EEG

• Some EEG: ? Pathognomonic

EEG in viral encephalitis

• Generalized slowing

• Depending on severity

• Non-specific finding

Herpes simplex encephalitis (HSE)

• A prominent focal abnormality
  – Focal polymorphic delta activity
  • Temporal region > frontal > others

• Pseudo-periodic, focal/unilateral, large amplitude, sharp wave complexes

• Repeat every 1-3 seconds

• Periodic lateralized epileptiform discharges (PLEDs)

PLEDs in HSE

• Appearing ~ day 2nd -15th of condition

• Another side affecting

• Synchronous or dependent PLEDs

• Asynchronous or independent PLEDs

• DDX:
  – Acute focal cerebral hemispheric processes
    • Abscess, infarction, neoplasm

Subacute sclerosis panencephalitis (SSPE)

• Pediatrics

• Measles

• EEG:
  – Initial EEG
    • Abnormal during sleep
    • Asymmetry discharge with contralateral myoclonic jerks

  – Late EEG
    • Bilateral synchronous & symmetrical high-amplitude periodic complexes
    • Repeat every 4-10 seconds with myoclonic jerks
Creutzfeldt-Jakob disease (CJD)

- EEG
  - Early or intermediate disease (first 3 months)
    - Periodic, bilaterally synchronous wave forms
    - Diphasic or triphasic sharp waves
    - Repeat regularly ~ 1Hz with myoclonic jerks
  - Late disease
    - Bilateral symmetrical & synchronous periodic discharges superimposed on a flat background

Periodic patterns: periodic sharp wave complexes

Degenerative encephalopathies

- Lesions
  - Cortical white matter
  - Cortical gray matter
  - Infratentorial lesion
Cortical white matter diseases

- Leukoencephalopathies

- EEG
  - Abnormal background
  - High-amplitude continuous generalized polymorphic delta activity

Cortical gray matter

- EEG:
  - Normal, or disorganized background
  - Slow, irregular and low in amplitude abnormal

- Alzheimer’s & Pick’s disease
  - Non-specific findings
    - Minimal continuous generalized polymorphic delta activity
    - Severe case: sharp or triphasic waves over posterior head region, not persistent

Huntington’s disease

- Clinical diagnosis and genetic test

- EEG
  - A flat tracing absence of any EEG activity in excess of 10 µV (even hyperventilation)
  - No rhythmic activity

Infratentorial lesion

- Examples
  - Spinocerebellar degeneration
  - Parkinson’s disease
  - Progressive supranuclear palsy

- EEG
  - Normal
  - Non-specific slowing of background activity

Summary EEG in Encephalitides & Degenerative encephalopathies

- General concepts
  - Common
  - Clinical diagnosis > EEG
  - Some EEG: ? Pathognomonic
    - CJD
    - SSPE
  - Serial EEG

DDx: brainstem injury

Polymorphic slowing