EEG pattern in Patients with Alteration of Consciousness

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EEG pattern in Patients with Alteration of Consciousness

• Scope
  – Diffuse encephalopathy
  – Encephalitides & degenerative encephalopathies
  – Status epilepticus
    • Especially in comatose patients

Introduction: diffuse encephalopathy

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

EEG in adult patients with altered mental status

From Diffuse encephalopathy

EEG in 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
• More severe
• Less common
Common EEG patterns

- Generalized slowing
  - Background slowing
  - Intermittent slowing
  - Continuous slowing

Background slowing: mild severity

Background slowing with paradoxical activation

Intermittent slowing: moderate severity

- Posterior dominant background and reactivity
- Burst of high amplitude rhythmic generalized slowing
  - Polymorphic delta
  - Intermittent burst of theta
- FIRDA
  - Frontal intermittent rhythmic delta activity
- OIRDA
  - Occipital intermittent rhythmic delta activity

Burst of generalized slowing

FIRDA
(Frontal intermittent rhythmic delta activity)
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

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-PEDs (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 µV ~5-10 seconds
- Common pattern of anoxic encephalopathy
  - DDx: drug & hypothermia

Burst-suppression pattern

Burst-suppression pattern

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

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

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. Un-reactive
2. Anterior-posterior lag
3. Not only hepatic encephalopathy
4. Adult > children

Severity assessment

<table>
<thead>
<tr>
<th>Grade</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Dominant activity is alpha rhythm with minimal theta activity</td>
</tr>
<tr>
<td>Grade II</td>
<td>Dominant theta background with some alpha and delta activities</td>
</tr>
<tr>
<td>Grade III</td>
<td>Continuous delta activity predominates, little activity of faster frequencies</td>
</tr>
<tr>
<td>Grade IV</td>
<td>Low-amplitude delta activity or suppression-burst pattern</td>
</tr>
<tr>
<td>Grade V</td>
<td>Nearly “flat” tracing or electrocerebral inactivity</td>
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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

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

EEG in diffuse encephalopathy

- Summary
  - 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
EEG in adult patients with Encephalitides & degenerative encephalopathies

Introduction

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

EEG in viral encephalitis

- Generalized slowing
  - Depending on severity
  - Non-specific finding

Encephalitides & Degenerative encephalopathies

- Common
- Clinical diagnosis > EEG
- Some EEG: ?? Pathognomonic

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
HSE and PLEDs over Rt temporal region

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

EEG in SSPE

Creutzfeldt-Jakob disease (CJD)

- Transmittable disease from Prion protein
- Spongioform encephalopathy
- Clinical
  - Rapidly progressive dementia
  - Myoclonus

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
**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

**Encephalitides & Degenerative encephalopathies**

- General concepts
  - Common
  - Clinical diagnosis > EEG
  - Some EEG: 7 Pathognomonic
    - CJD
    - SSPE
  - Serial EEG
Introduction

- Definition of status epilepticus (SE)
- Types of SE
- EEG in SE
- Target EEG for treatment refractory SE

Status epilepticus in adult comatose patients

Esp. in comatose patient without clinical convulsion

Types of SE in non-epilepsy patient

- Simple partial or focal status
  - Epilepsia partialis continua
- Generalized convulsive SE
  - Generalized tonic-clonic seizures
  - Subtle convulsive status epilepticus
- Non-convulsive SE (electrographic SE)
  - Clinical: confusion, obtundation, coma

EEG characteristics in SE

- More important in NC-SE > convulsive-SE

- EEG
  - Continuous or repetitive discharges of polyspikes spike-and-waves
  - Lateralized periodic discharges
    - Periodic epileptiform discharges (PEDs)
    - Bilateral periodic epileptiform discharges (Bi-PEDs)
    - Generalized periodic epileptiform discharges (GPEs)
  - Diffuse rhythmic waxing and waning delta or theta activity
  - Some degrees of electrographic response to benzodiazepine injection

NC-SE in severe anoxic encephalopathy
Continuous spike-wave

Bilateral periodic epileptiform discharges in a patient with subarachnoid hemorrhage

Continuous spike-wave activity

After a benzodiazepine injection

EEG target patterns for treatment of refractory SE

- SE continuing after treatment for 1 hour
- Rx: intravenous anesthesia
  - Pentobarbital, midazolam, phenobarbital
  - Loading dose
  - Continuous intravenous infusion
- EEG target
  - Suppression-burst pattern
  - Continuous bedside EEG monitoring
  - Tailed medication every 12-24 hours

Burst suppression:
EEG target for Rx of refractory SE
Status epilepticus

- Uncommon but medical emergency
- High mortality and morbidity
- Neuronal damage & Epileptogenesis
- EEG monitoring
  - Importance diagnostic tool esp. in NC-SE
  - Monitoring treatment target for refractory SE
  - Also for treatment titration

Thank you for Your attention