Abnormal EEG Patterns

correlation with underlying cerebral lesions and neurological diseases

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Definition of the abnormal EEG

An EEG is abnormal if it contains
• Epileptiform activity
• Slow waves
• Amplitude abnormalities or
• Deviations from normal patterns

In most abnormal EEGs, the abnormal patterns appear
• only intermittently
• only in some channels or
• only superimposed on a normal background

Approach to the orderly visual analysis of EEG activity

Examine EEG

BACKGROUND
TRANSIENTS

Normal for Age/State
Abnormal

Generalized
Focal

Slow waves

Usually characterized as
• focal or generalized
• rhythmic (monomorphic) or polymorphic (arrhythmic)
• intermittent or continuous
• dominant frequency (delta or theta)
Focal slow waves

- Waves of < 8 Hz appear at mainly in focal distribution over a few electrodes, less often over the entire hemisphere
- Intermittent or continuous

Focal slow waves

1. Local structural damage of subcortical white matter or thalamus: stroke, tumor, abscess
2. Local disorders of cerebral blood flow or metabolism: TIA, migraine, postictal condition

Focal slow waves

<table>
<thead>
<tr>
<th>Intermittent slow</th>
<th>Continuous slow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theta</td>
<td>Theta or Delta</td>
</tr>
<tr>
<td>Focal</td>
<td>Focal</td>
</tr>
<tr>
<td>Reactive</td>
<td>Reactive or nonreactive</td>
</tr>
<tr>
<td>Focal brain dysfunction</td>
<td>Focal structural lesion</td>
</tr>
</tbody>
</table>

Focal slow waves

Polymorphic delta activity

- continuously present
- variability in waveform, amplitude, duration and morphology
- usually, but not always, maximum over the lesion
- persists during changes in physiologic state
- indicates focal structural lesion

Focal slow waves

- More related with superficial lesions
- Increased localizing value when topographically discrete or associated with depression of intermixed faster background frequencies
- May be associated with similar slow waves in the opposite hemisphere (usually lower amplitude)
Generalized asynchronous slow waves

- Waves of < 8 Hz appear over both hemispheres, no constant time relationship of waves between each side
- Vary in frequency
- Irregular shapes
- May be reduced by eye opening, alerting and increased by hyperventilation

Generalized asynchronous slow waves

- Must be differentiated from normal drowsy and sleep stage
- Marked amount and less reactivity indicate cerebral abnormality
- Most common and least specific EEG abnormality, 10-15% in mild degree cases have no detectable abnormality

Generalized asynchronous slow waves

1. Wide spread structural damage including subcortical white matter: CVD, head injury, degenerative disease, CNS infection
2. Generalized cerebral dysfunction: anoxia, syncope, migraine, coma, interictal or postictal condition, psychiatric disorders, metabolic and toxic encephalopathies,

Bilaterally synchronous slow waves

- Waves of < 8 Hz appear simultaneously in corresponding parts of both hemispheres
- May be distributed over the entire head or limited bilateral regions
- Commonly monomorphic, but may be irregular and arrhythmical
- Reduced by eye opening, alerting and increased by drowsiness, hyperventilation
Bilaterally synchronous slow waves

2 main categories

1. Delta frequency, medium to high amplitude, regular and rhythmical: intermittent rhythmical delta activity (IRDA) >>> FIRDA, OIRDA

2. Delta or theta frequency, low to medium amplitude, irregular and arrhythmical

Bilaterally synchronous slow waves

Normal bisynchronous slow waves

1. During drowsiness and sleep at any age
2. During wakefulness in age < 20 years
3. Response to hyperventilation at any age, esp. childhood
4. Adult with rare patterns of slow alpha variant and of posterior slow waves

Bilaterally synchronous slow waves

1. Diffuse dz damaging subcortical and cortical gray matter: dementia, PSP, multiple sclerosis, hydrocephalus, head injury, CNS infection, and etc.

Bilaterally synchronous slow waves

2. Local structural lesions which directly involve or compress deep midline structures: tumor or stroke at or near the bottom of anterior, middle or posterior fossa

Bilaterally synchronous slow waves

3. Metabolic, toxic, and endocrine encephalopathies those affect the function of mesencephalic and diencephalic centers: hepatic, renal, hypoparathyroid encephalopathies

4. Others: Seizure disorders (interictal, postictal), Psychiatric disorders

Brief paroxysm
Local and lateralized differences of amplitude: Asymmetries

- Usually affect all types of background activity during wakefulness and sleep
- May affect only particular frequency band or waveform: alpha, beta, mu rhythm, sleep patterns
- > 35% of beta or > 50% of alpha considered abnormal asymmetry
- Associated with 0.5-2 Hz reduction in frequency

Local differences of amplitude

1. Local decreased EEG production: structural cortical damage (e.g., infarction, contusion, CNS infection) or dysfunction (TIA, migraine)
2. Local change of media between cortex and recording electrode
   - Increase: SDH, scalp swelling
   - Decrease: surgical skull defect (breach rhythm)

Background asymmetry

Generalized changes of amplitude

- Bilateral symmetrical decrease or increase of amplitudes of all types of normal activity or specific patterns only
- Normal high amplitude occurs in waking children and deep stages of sleep at any age
## Generalized changes of amplitude

1. Generally decreased EEG production
   - No detectable abnormality (5-10% of normal adults)
   - Structural dz of cerebral cortex: postanoxia, Huntington’s chorea
   - Disorder of cortical function: Hypothyroidism, intoxications, anxiety, etc.

2. Bilateral increase of media between cortex and recording electrodes: SDH

## Deviations from normal patterns

### Deviations from normal patterns

1. Bilateral decrease of alpha frequency: generalized cerebral dysfunction or metabolic disorder, reduced alertness, bilateral structural damage of occipital cortex or its thalamic input

2. Unilateral decrease of alpha frequency: unilat. cerebral dysfunction (eg. TIA, mild head injury) or unilat. structural change (eg. Chronic SDH, infarct, severe injury)

## Alpha coma pattern 1

6. Absence of alpha rhythm, presence of occipital spikes: long standing dz of both eyes or central visual path (eg. Binocular blindness)

7. Alpha frequency coma: central pontine lesions or wide spread damage

8. Ictal activity of alpha or beta frequency: local or widespread cerebral damage in newborns or irritative temporal lobe lesions (CPS)