EEG IN CHILDREN: NORMAL AND ABNORMAL

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EEG Course
FSNC/CNSF
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OBJECTIVES

- Survey some abnormal and normal patterns
- Maturation characteristics
- Artefact recognition
- Patterns from superimposed components
- Normal/abnormal not always distinct
- Paediatric EEG knowledge improves adult EEG interpretation
5 QUESTIONS ABOUT PAEDIATRIC EEG

- In what **state** is the patient? Drowsiness and sleep occupy a high percentage of children’s recordings; their features are in some aspects distinct from those of adults.
- Is the electrical **maturation** for each stage adequate?
- Are there any persistent, marked, and non-artefactual **asymmetries** which are not accepted for the waveform in question?
- Are there any **spikes**? These must be distinguished from other sharply contoured waves.
- Does focal or diffuse **excess delta** activity exist for this patient’s age and state?
Passive Eye Closure Demonstrates Background Activity

A: With eyes open: 5 Hz better left

B,C: Passive eye closure: 9 Hz better right.

Fig. 1a
Passive Eye Closure Demonstrates Background Activity

A: With eyes open: 5 Hz better left

B,C: Passive eye closure: 9 Hz better right.
Lack of Alpha With Eye Closure, 6 yrs

FP1 - F3
F3 - C3
C3 - P3
P3 - O1
Fp2 - F4
F4 - C4
C4 - P4
P4 - O2

EC

100μV 1 second
Right Hemisphere Hypoactivity
(3 Years)

Although there is excess delta activity on left, the paucity of right hemisphere activity is the principal abnormality.
Right Hemisphere Hypoactivity
(3 Years)

- Right temporal hypoactivity is principal abnormality.
- Right central-parietal (C₄-P₄) delta.
- Mild excess left hemisphere delta.
POSTERIOR DELTA
Posterior-Accentuated Delta
(6 Years)

Although delta is most prominent at 0₁, 0₂, P₄; excess delta appears more anteriorly.
Fig. 4
POSTERIOR DELTA

CLINICAL SIGNIFICANCE

- Recent seizure
- Mild to moderate recent trauma
RHYTHMIC POSTERIOR DELTA

• Normal, or
• Hidden spike-waves
FOCAL DELTA
ARTEFACT  NORMAL  ABNORMAL
Focal Delta
(7 Years)

2-3 Hz arrhythmic delta at F$_4$-C$_4$.  

Fig. 5
Fig. 5

Electroencephalogram (EEG) showing typical patterns for different electrode pairs:
- FP1 - F3
- F3 - C3
- C3 - P3
- P3 - O1
- FP2 - F4
- F4 - C4
- C4 - P4
- P4 - O2

Scale: 100 µV per vertical division, 1 second per horizontal division.
NORMAL POSTERIOR RHYTHMS AND FEATURES
• Anything maintaining an invariably regular frequency is likely to be normal.

• Sharp elements that clearly grow out of an ongoing baseline rhythm should be considered normal.

Engel 1984
AWAKE

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

8 yrs

100μV

1 SEC
POLYPHASIC POTENTIALS
– 250-500 msec
– among alpha
– “polyphasic morphology”
– often more abundant on right

RHYTHMIC WAVES
– 3-4 Hz
– upon eye closure
POLYPHASIC POTENTIALS
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RHYTHMIC WAVES
- 3-4 Hz
- upon eye closure
LAMBDA
- Apiculate
- Positive
- Eyes open

OCCIPITAL SPIKES
- Apiculate
- Negative
- Eyes closed
CENTRAL PHENOMENA
Epileptiform Abnormalities: ROLANDIC SPIKES

• Abundant and stereotyped.

• Unilateral, bilaterally independent, and/or bilaterally synchronous.

• Background normal when spikes absent.
• Seizures in 54 - 84%
EPILEPTIFORM:
GENERALISED
Generalised Epileptiform Phenomena:

GENERALISED SPIKE-WAVE

• Bilaterally synchronous spike-wave complexes with repetition rate of 2.5 to 4 Hz.

• Bursts begin and end abruptly.

• Repetition rate slows during long paroxysms.

• Maximum amplitude usually at F3, F4; occasionally posterior (P3,4; 01,2).
Generalised Epileptiform Phenomena: POLYSPIKES

- Burst of spikes repeating at 10-25 Hz.
- Irregular discharge rate.
- Generalised, maximum frontally.
- 40-350 μV.
- Duration 1-8 seconds.
- Tonic seizures or absence in association.
- May occur on eye closure.
Epileptiform Abnormalities: SLOW SPIKE-WAVES (SSW)

- Bilaterally synchronous sinusoidal waves, each accompanied by a sharp wave or spike forming a complex.
- Repetition rate less than 2.5 per second.
- Onset and offset less abrupt than spike waves.
- Occupy high percentage of recording.
- Often no discernible clinical alteration.
- Associated with a slow background.
Fast rhythmic waves

- Bursts of 8- to 30-Hz widespread or generalised waves.
- Usual clinical accompaniment is tonic seizure when hypsarrhythmia or slow spike-waves appear in same record.
- Usual clinical accompaniment is absence attack when spike-wave complexes appear in same record.
LENNOX-GASTAUT SYNDROME

CRITERIA

• Generalised seizures
  – Tonic
  – Atypical absence
  – Others

• EEG: slow spike-waves
  epileptic recruiting rhythm =
  fast rhythmic waves
SECONDARY BILATERAL SYNCHRONY

• Bilaterally synchronous discharge
• Can be shown to arise from a unilateral cortical focus
• Origin usually from most “active” spike focus
• Usually frontal
Normal Drowsiness, Sleep, And Arousal: BURST DROWSY

• Bursts of 2- to 5-Hz sinusoidal waves, usually maximum frontocentrally.
• Superimposed on other drowsy patterns.
• Begin at 14 to 18 months; most common at 3 to 5 years; seen until 11 years.
Normal Drowsiness, Sleep, And Arousal: V-WAVES

- Higher voltage and briefer than in adults, therefore, spike-like.
- Variable morphology and polarity.
- May occur sequentially.
- Shifting asymmetries.
- Begin at 3 to 4 months, maximum at 3 to 4 years.
SPINDLES

- First clearly expressed at 3 to 4 months.
- More numerous and longer at 3 to 9 months than later.
- Asynchrony common in first year.
- Central-parietal location in early childhood.
- May be comb shaped.
ASYNCHRONOUS, SHARPLY CONTOURED SPINDLES

SLEEP

AGE 8 mo.

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

70 µV
1 SEC
Absent Spindles

5 mos
AROUSAL

- 4-6 Hz rhythmic waves diffusely
- 1-3 Hz diffuse delta
- Principally < 5 years
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END
NORMAL

AWAKE

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

AGE 3 mos

1 SEC 100 µV
Fig. 6. Boy R. T., 35 days old. At the top: the curve recorded from forehead and occiput by means of silver foil electrodes and with the coil galvanometer; in it the v-w of the E.E.G. can be recognized. At the bottom: time in 1/10ths sec.

Fig. 7. Child E., 6 months and 5 days old. At the top: the E.E.G. recorded from forehead and occiput by means of silver foil electrodes and with the coil galvanometer. At the bottom: time in 1/10ths sec.
Subtle Focal Delta
(9 Years)

- Abnormal delta quantity right frontal-central (F₄-C₄) region.
- Normal delta amount on left.
Epileptiform Abnormalities: ROLANDIC SPIKES

- High voltage at C3 or C4 using 10-20 System.

- Involve principally lower Rolandic area (C5,6) using closely spaced electrodes.

- Marked downward deflection at F3-C3 or F4-C4 suggests dipole.

- Principal parasagittal spread of negative component usually parietal, occasionally frontal.
POLYSPIKE AND WAVE

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

EYES CLOSED

AGE 16

100 μV
1 SEC
• Spike wave quantity = amount of absence seizures