EEG course: *Normal variants*

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Normal (benign) variants

"Variation of normal rhythms, less commonly seen,
NOT associated with disease or uncertain clinical significance."

"These patterns may at times appear *'suspicious'*."

ORIGINAL ARTICLE

Benign EEG variants in the sleep–wake cycle: A prospective observational study using the 10–20 system and additional electrodes

To investigate each type of benign EEG variants (BEV)

Continuous video-EEG monitoring ≥24 h

University hospital of Montpellier, France

n = 1163, aged 33 (1-84) y, 53% female

- Benign variants noted in 61%
- 51% >1 BEVs, 4% ≥4 BEVs

Benign variants	% of total (n = 1163)
POSTs	36.4
Mu rhythm	22.4
Lambda waves	16.7
Wicket spikes	15
14- and 6-Hz positive bursts	8.3
Small sharp spike (SSS)	3.3
RMTD	2.15
Midline theta rhythm	2.1
Six-Hz spike-wave	0.1

Macorig et al. *Neurophysiol Clin* 2021

Normal variants: source of misadventure in EEG

Prevalence of benign epileptiform variants from an EEG laboratory in India and frequency of their misinterpretation

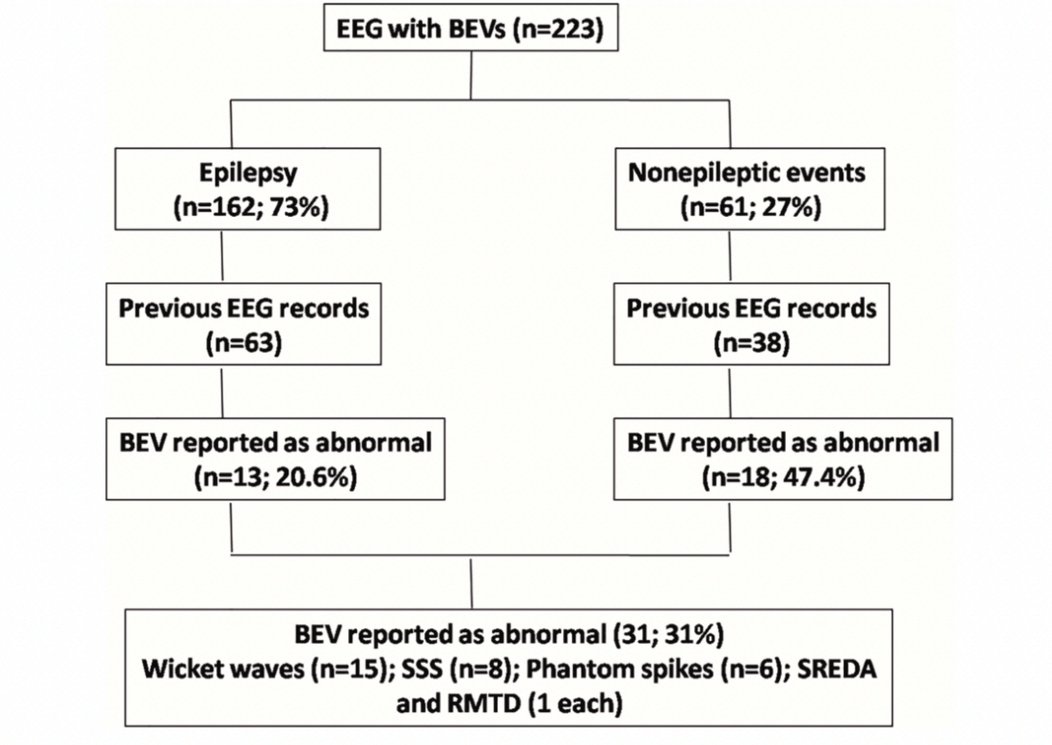
Chaturbhuj Rathore *, Sanjay Prakash, Kaushik Rana, Prayag Makwana

Department of Neurology, Smt. B. K. Shah Medical Institute and Research Center, Sumandeep Vidyapeeth, Vadodara, Gujarat, India

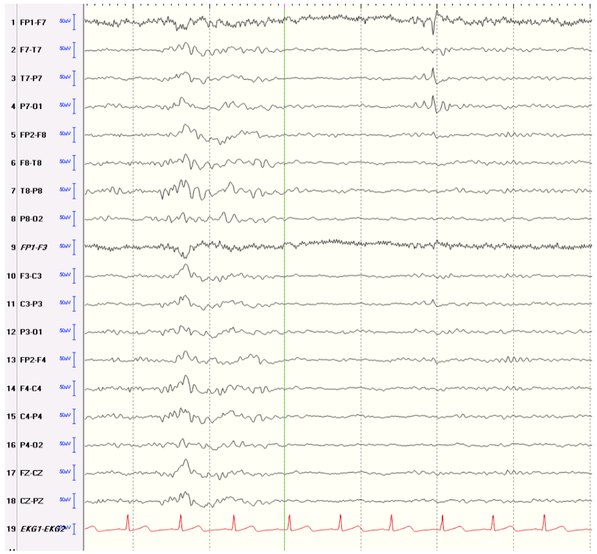
To study prevalence of benign variants and impact on misdiagnosis

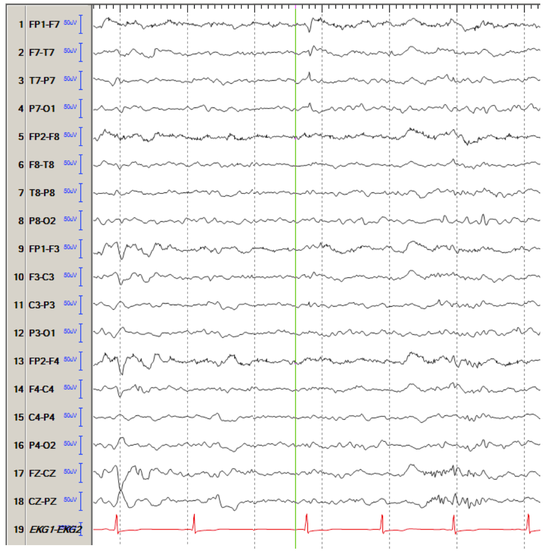
EEG >40 min, Sumandeep Bidyapeeth, India

n = 1862, aged 23(1-86) y, 60% male



- Benign variants noted in 12%
- Overinterpreted as epileptiform activity in 30%





Rathore et al. *Epilepsy Res* 2021

Normal (benign) variants

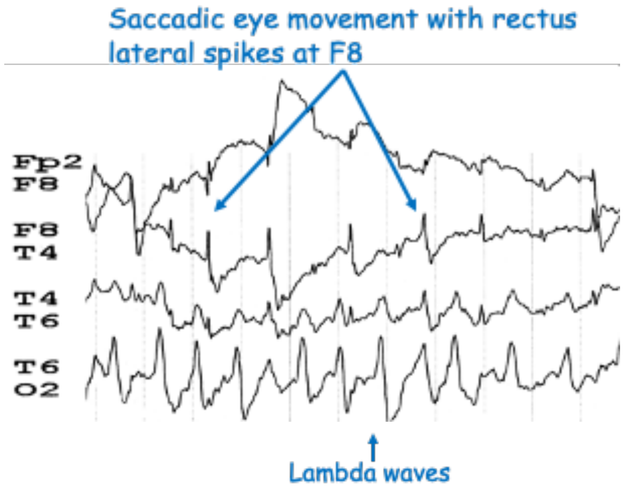
Epileptiform variants
Lambda waves
Mu rhythm
Wicket spikes/rhythm
Small sharp spikes (SSS)
14- and 6-Hz positive bursts
6-Hz spike-wave complexes

Rhythmic variants
RMTD
Midline theta rhythm
SREDA

Variation of Normal
Alpha variants
Breach rhythm

Lambda waves

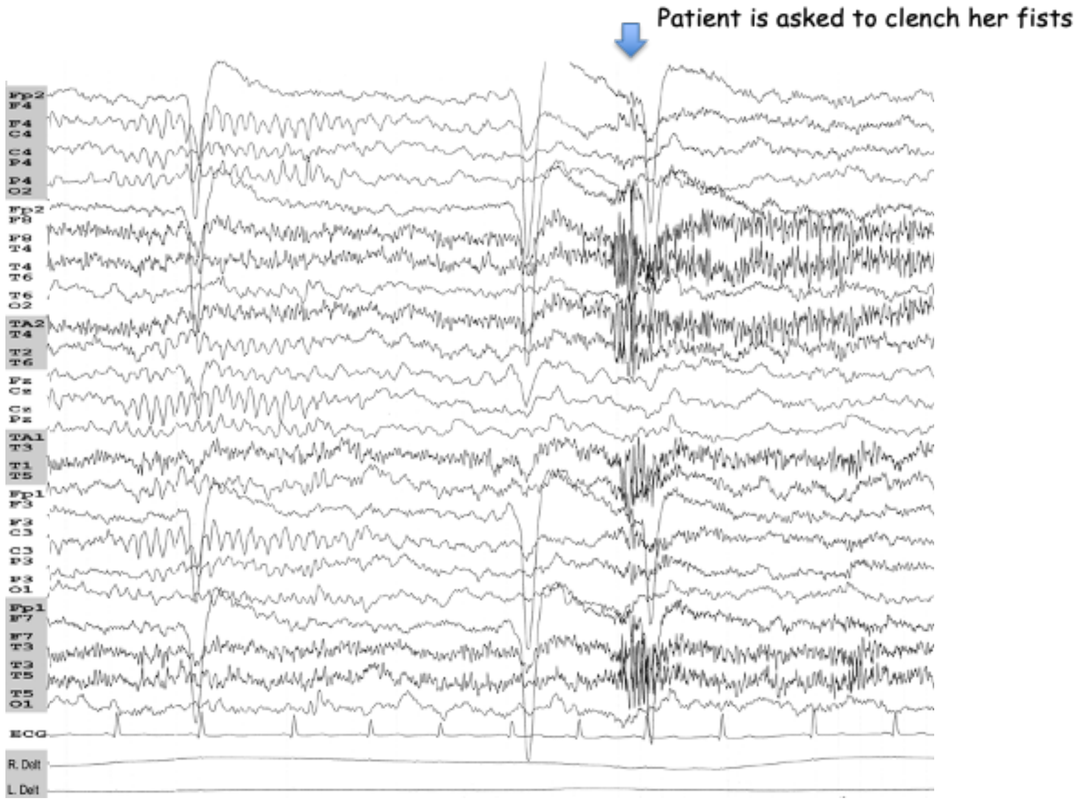
Characteristics	
Polarity	Positive
Location	Occipital regions
Morphology	Sharp, mono- or diphasic-
Duration, Frequency	100-250 ms
Amplitude	<50 μV
State of alertness	Awake
Reactivity	Scanning eye movement
Age	Children/adolescents/Young adults
Note	Synchrony



	Lambda	POSTs
State of alertness	Awake	Sleep

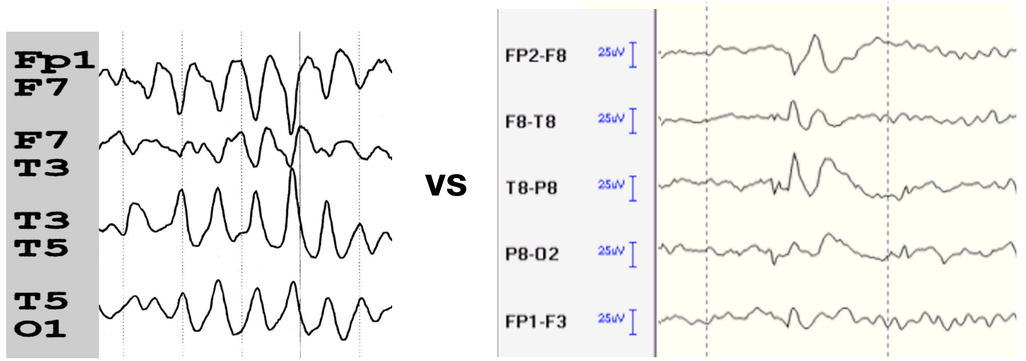
Mu rhythm

Characteristics	
Polarity	Negative
Location	Central or centroparietal
Morphology	Arciform or comb-like
Duration, Frequency	7-11 Hz, bursts up to few sec
State of alertness	Awake
Reactivity	Block by movement
Age	Later childhood - adult
Note	Often asynchrony



Wicket spikes/rhythm

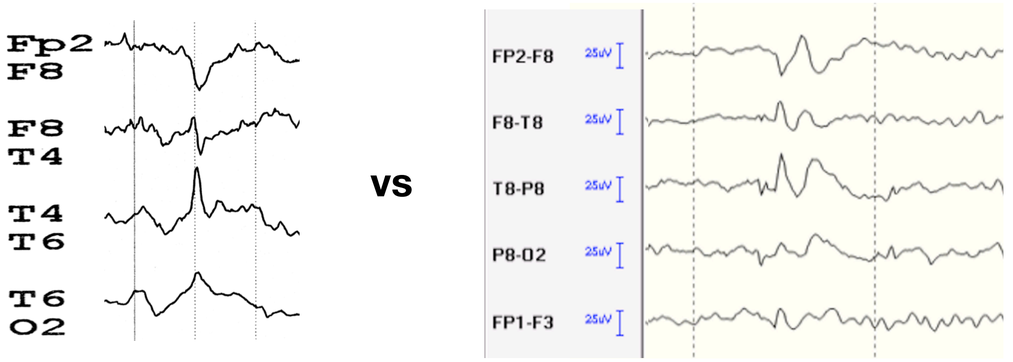
Characteristics	
Polarity	Negative
Location	Temporal
Morphology	Arciform
Duration, Frequency	6-11 Hz, bursts up to a sec
Amplitude	60-200 μV
State of alertness	Light sleep
Age	Adults (>30 YO)
Note	Usually asynchrony, 1-3%



Wicket spikes		Sharp wave
No	Aftercoming slow	Yes
No	Disrupt background	Yes
Equal rise and decay	Morphology	Asymmetry

Small sharp spikes (SSS)/ Benign epileptiform transients of sleep (BETS)

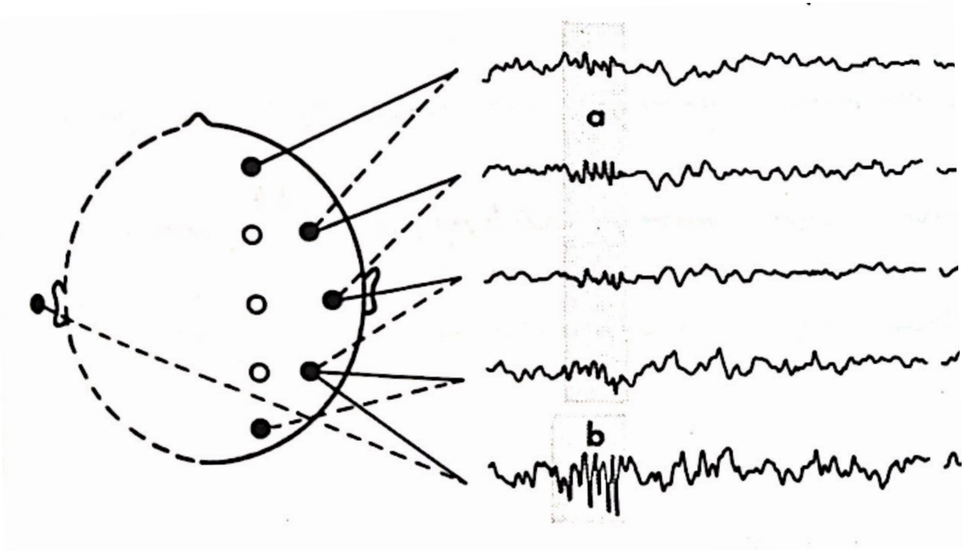
Characteristics	
Polarity	Negative
Location	Temporal
Morphology	Mono- or diphasic spike, may vary within same individual
Duration, Frequency	<50 ms, singly
Amplitude	<50 μV
State of alertness	Light sleep
Age	Adults
Note	Uni- or bilateral, 20-25%



SSS		Spikes
Light sleep	State of alertness	State independent
No	Aftercoming slow	Yes
No	Disrupt background	Yes
Broad	Field	Narrow
Side-to-side shift	Bilateral	Consistent

14- and 6-Hz positive burst

Characteristics	
Polarity	Positive
Location	Posterior temporal & occipital
Morphology	Comb-shape
Duration, Frequency	14 and/or 6 Hz, burst ≤1 s
Amplitude	<75 μV
State of alertness	Light sleep
Age	Adolescence (rare, >25 y)
Note	Unilateral or bilateral, 10-58%

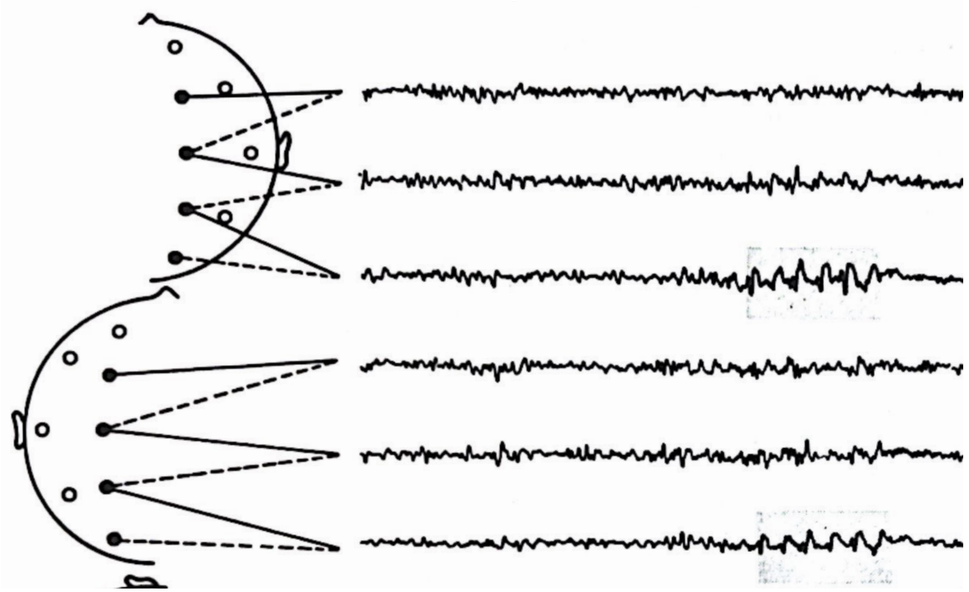


well demonstrated with contralateral ear reference

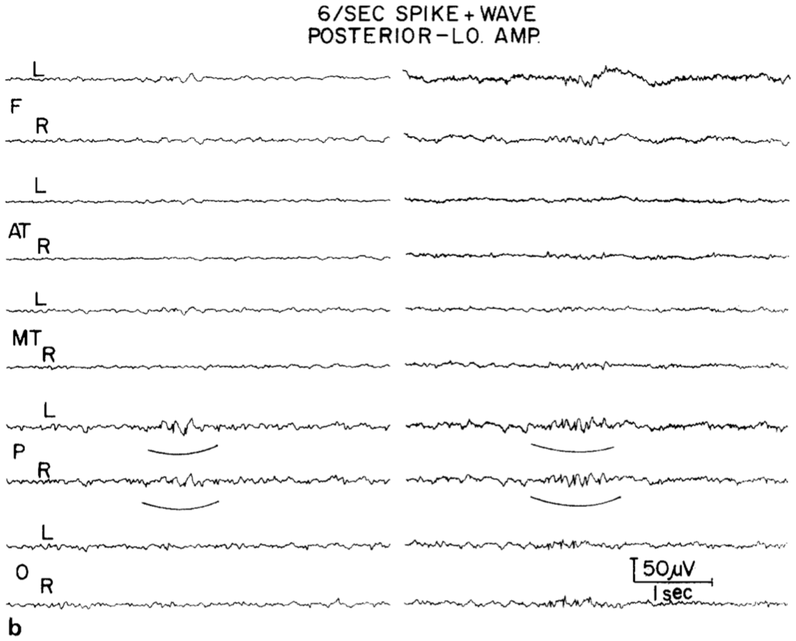
Six-per-second spike-wave complexes

Characteristics	
Polarity	Negative
Location	Generalized, max often posterior
Morphology	Spike-wave complexes
Duration, Frequency	5-7 Hz, spike <30 ms, 1-2 s
Amplitude	spike <40 μV
State of alertness	Awake/drowsiness
Age	Adolescents/Young Adults
Note	2-3% of normal population

“Phantom spike-wave”

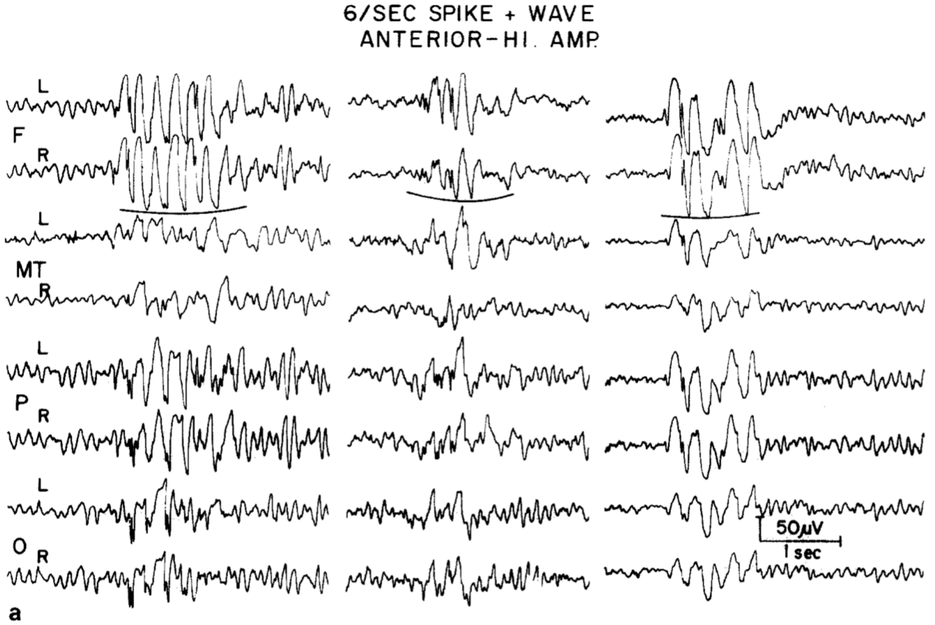


Six-per-second spike-wave complexes



FOLD: female, occipital, low amp, drowsy
This form is NOT associated with seizures

benign variant



WHAM: waking, high amp, anterior, males
This form is more likely associated with seizures

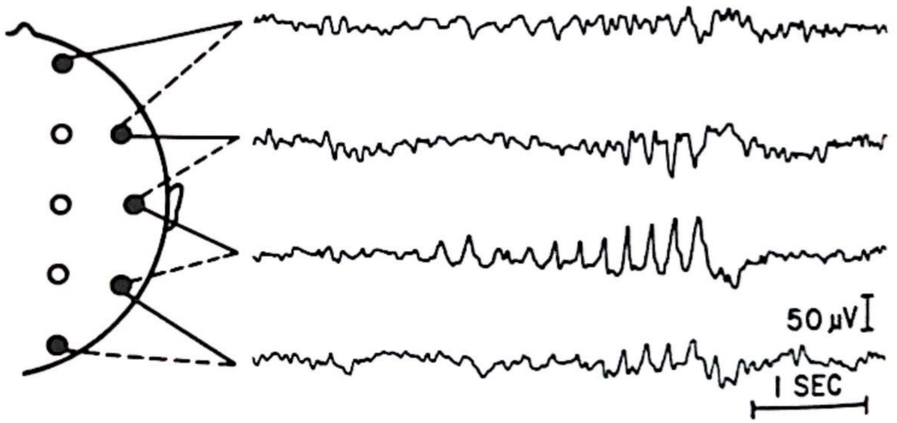
Hurges JR. *Electroencephalogr Clin Neurophysiol* 1980

Rhythmic midtemporal discharges (RMTD)

Characteristics	
Polarity	Negative
Location	Mid-temporal
Morphology	Negative sharp with notched or flat positive phases
Duration, Frequency	4-7 Hz, bursts up to a few sec
State of alertness	Light sleep
Age	Adults
Note	Uni- or bilateral, 0.5-2%

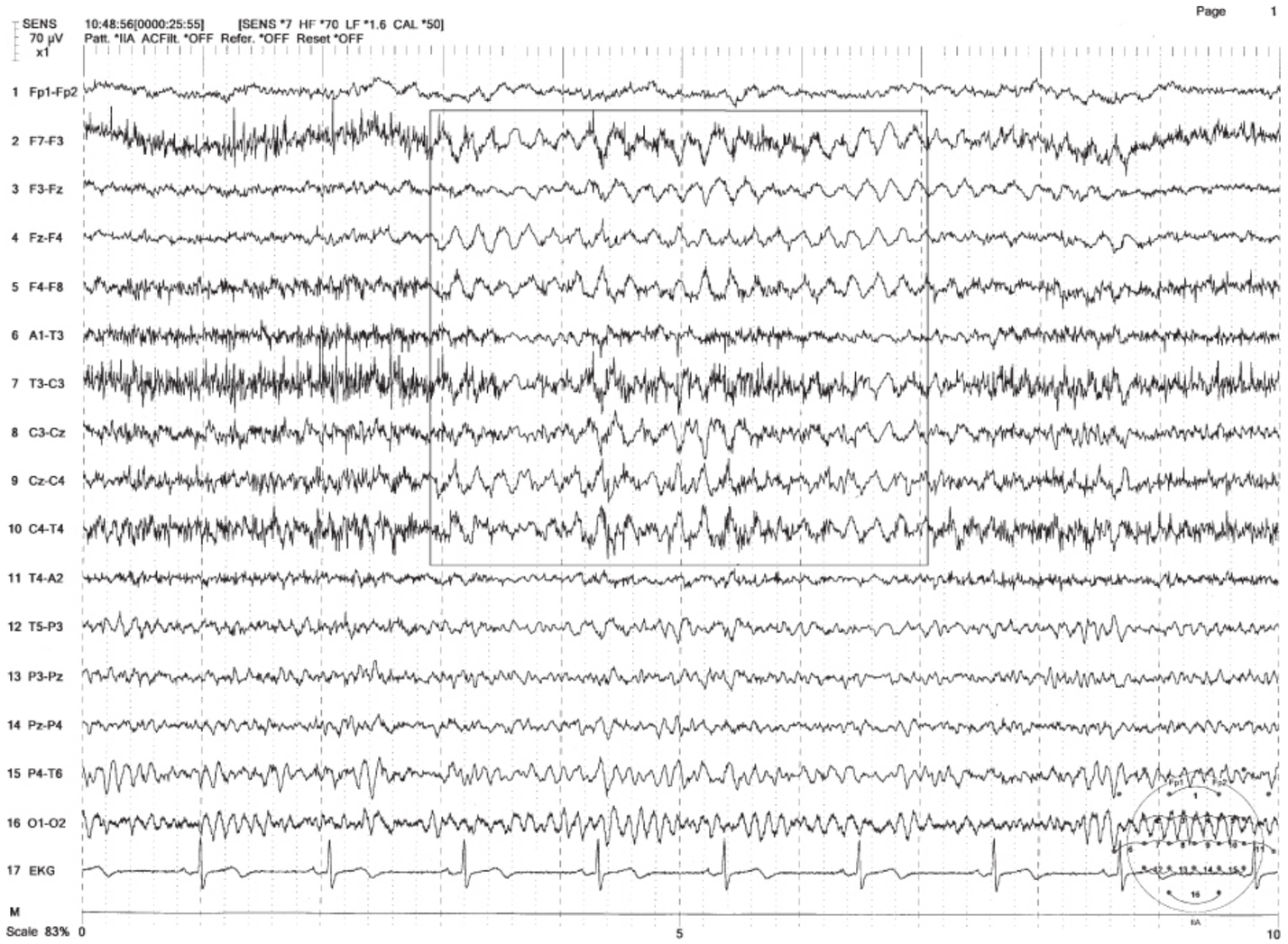
"Psychomotor variant"

"Rhythmic temporal theta bursts of drowsiness"



frequency/morphology remain stable!!!

Rhythmic theta activity in midline areas?

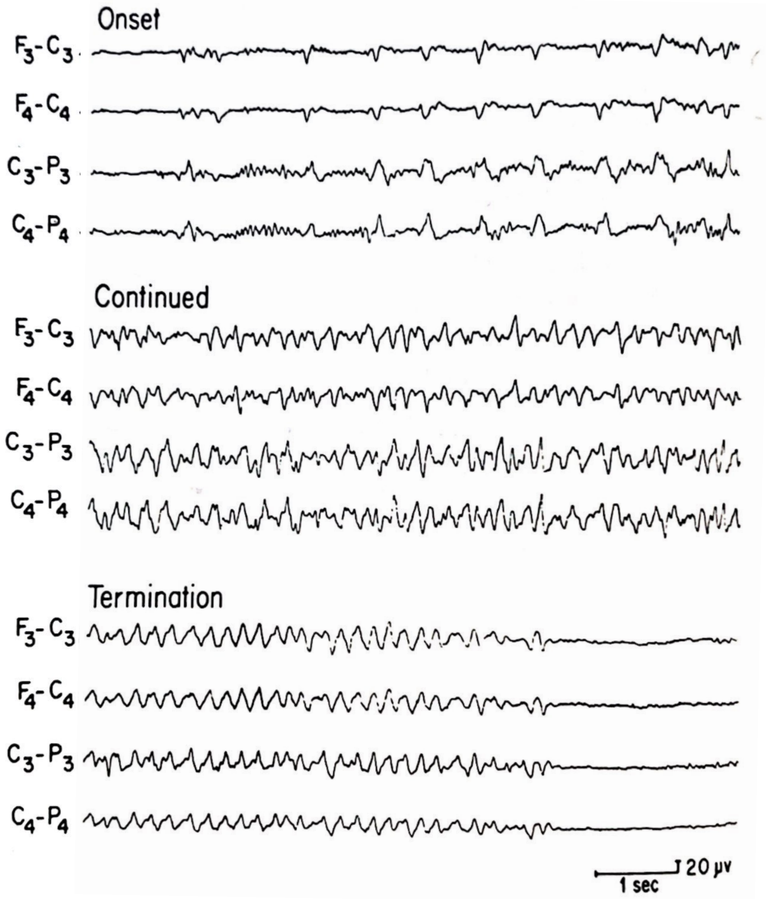


"Midline theta rhythms (of Ciganek)"

Characteristics	
Polarity	Negative
Location	Midline region
Morphology	Rhythmic theta activity
Duration, Frequency	4-7 Hz, 4-20 s
State of alertness	Awake/drowsy
Age	Children/Adults

Subclinical rhythmic EEG discharge of adults (SREDA)

Characteristics	
Location	Posterior temporal/parietal
Morphology	Repetitive sharp 0.5-1Hz → theta (abruptly ended w/o postictal slowing)
Duration, Frequency	<10 s to >5 min (40-80 s)
State of alertness	Awake/HV > light sleep (consciousness is preserved)
Age	>50 YO
Note	2/3 synchronous, 1/3 unilateral



rare 0.02% to 0.045% of routine EEG studies[1]

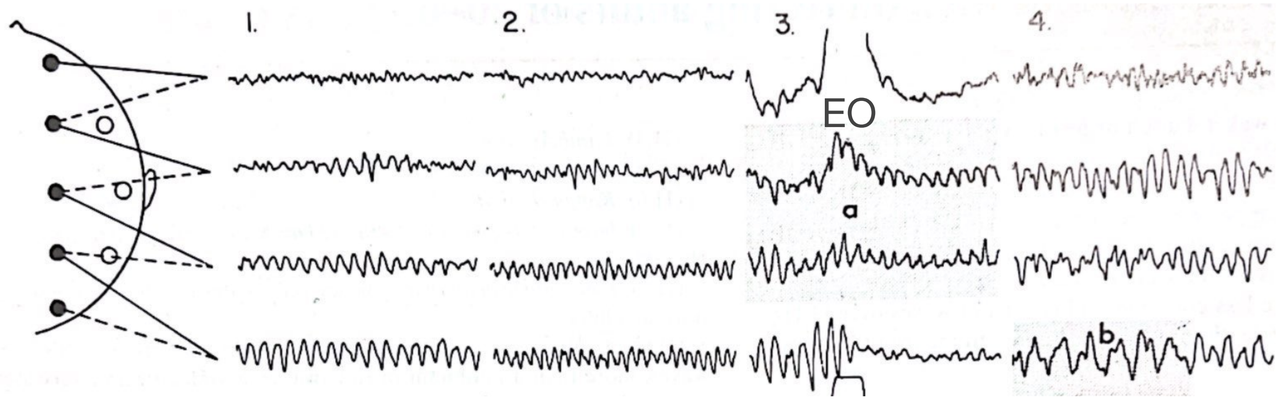
1. Herranz & Lopez. *Electroencephalogr Clin Neurophysiol* 1984

Alpha variants

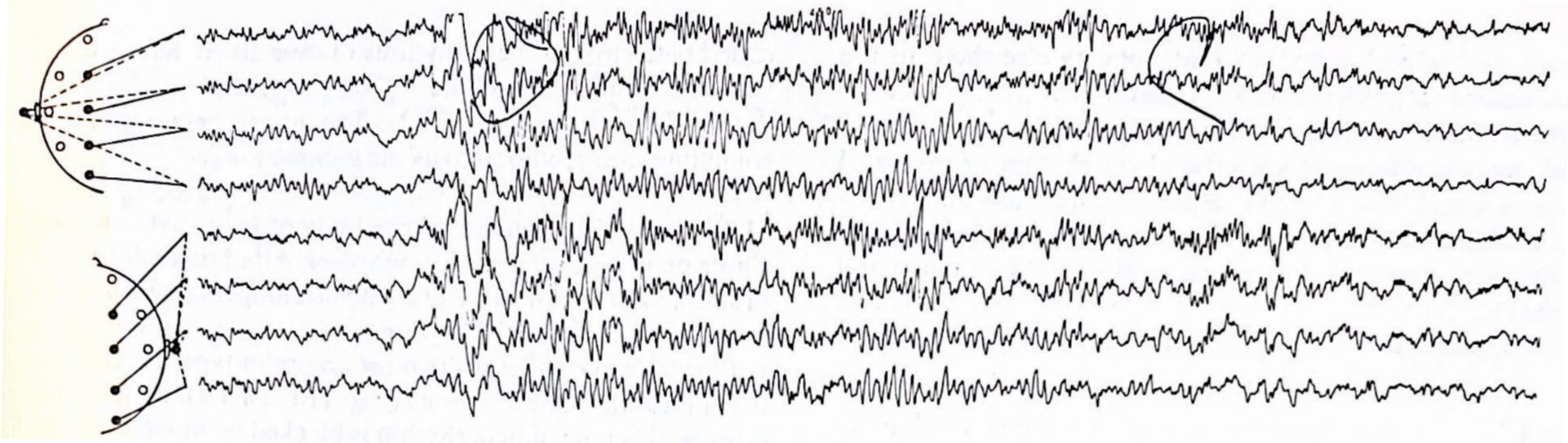
Regular alpha is often seen

Harmonic of alpha
"Fast alpha variant"

Sub-harmonic of alpha
"Slow alpha variant"



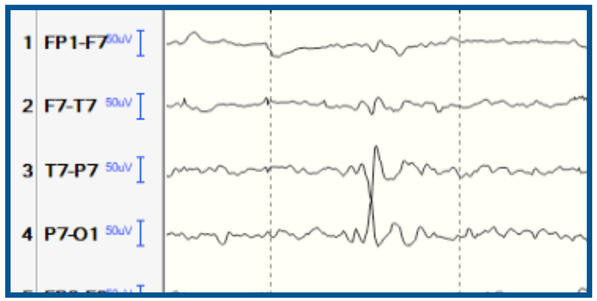
Paradoxical alpha rhythm: alpha rhythm appears on eye opening as partial alerting, and disappear with drowsiness returns

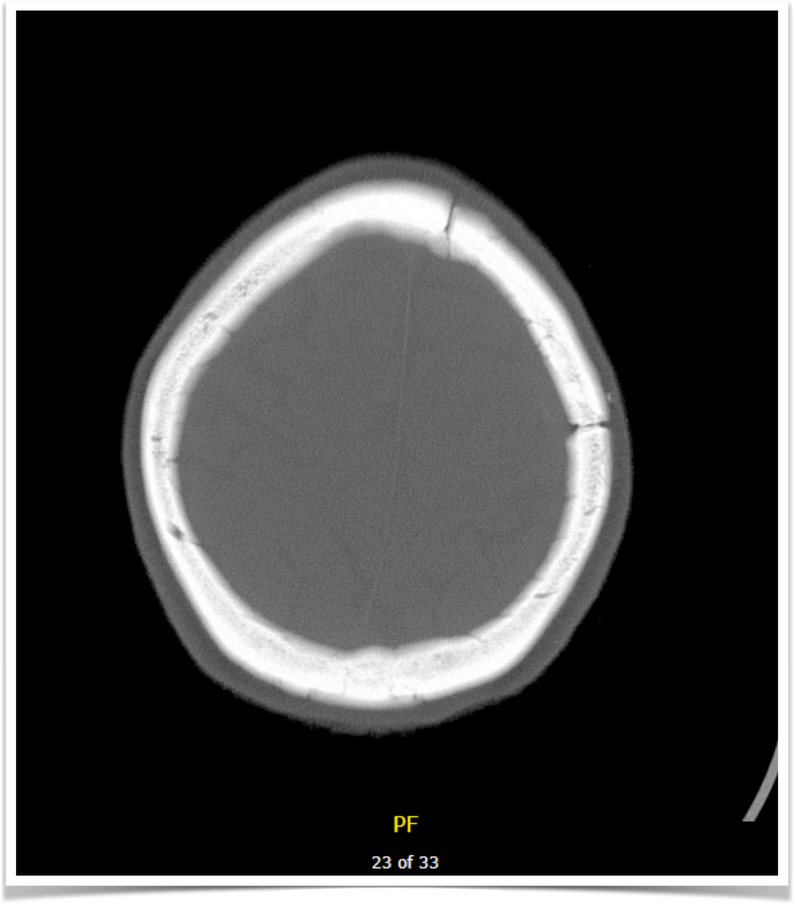


Fisch and Spehlmann's EEG Primer 3rd ed.

Breach rhythms

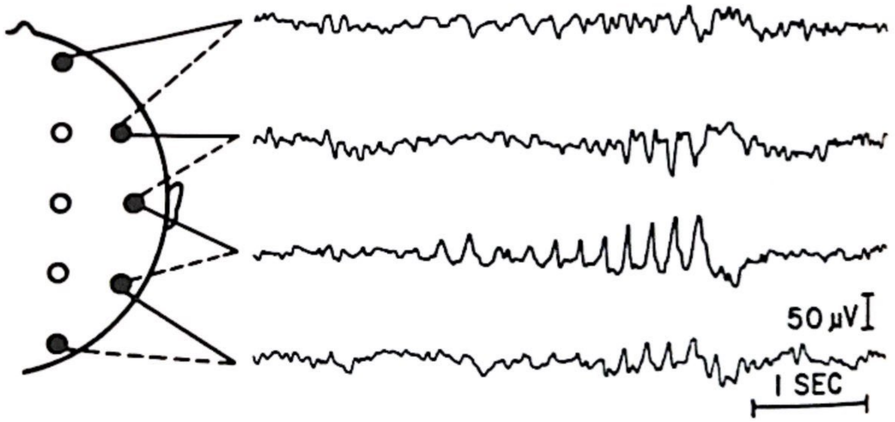
- Change in transmission of waves through area of skull defect
- Beta is attenuated by intervening tissues
- *Information about craniotomy scars is very important*
- **NOT** to misinterpret asymmetry
- Avoid mistaking fragments for spikes





Key facts of benign variants

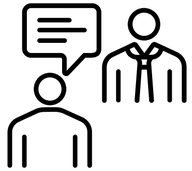
- Do NOT disturb the background activity
- Most are state dependent
  - ➡ disappearing during deeper stages of sleep or mental activation
- Do NOT evolve in frequency, field, or morphology



When in doubt…

1. Describe it

2. Wait for it to happen again
3. Ask someone



4. Call it normal

ขอบคุณครับ

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