Unique Characteristics in Young Children with Surgically Amenable Epilepsies

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Epilepsy Surgery Evaluation in Children

- **Basic pre-surgical screening tools:**
  - **Clinical evaluation & seizure semiology**
  - **Scalp VEEG**
  - **Brain MRI**
- **We will discuss:**
  - **Unique characteristics in the developmental context for accurate interpretation of these screening tools**

Onset: *Explosive*
Refractoriness: *Rapid*
Cognitive Decline*: Progressive*

- Usually seen < 2 years of age
- Medical treatment fails within weeks
- Epileptic encephalopathy may develop
- Toxic poly-pharmacy ⇨ encephalopathy
- Development and behavior regression
- Outlook dismal without remission

Child should be TIMELY screened for surgery – with in weeks/months

Seizure Semiology May Lack Features of Partial Onset

- Hallmarks of partial seizures absent
  - Unable to report auras
  - Bland elementary semiology until 4-6 yrs
  - Ictal exam during VEEG difficult
- Motor seizures are often generalized
  - Infantile spasms
  - Generalized tonic seizures
- Focal motor signs uncommon
  - Unilateral tonic limb extension – C/L
  - Eye tonic gaze – unreliable lateralization

Park et al., Seizure 2020; Hamer et al., 1999; Acharya et al., 1997

Neuro Deficits Difficult to Assess

- Mild motor & visual deficits not apparent
- Even in large hemispheric lesion, Hemiparesis may present only as:
  - Early hand preference
  - Asymmetry of limb movements
  - Gaze preference
  - Severity may become obvious overtime
- Neurodevelopmental assessment confounded by age and other factors

New Post-op Deficits difficult to predict – Good Plasticity favors early surgery

Epilepsy Surgery Evaluation in Children

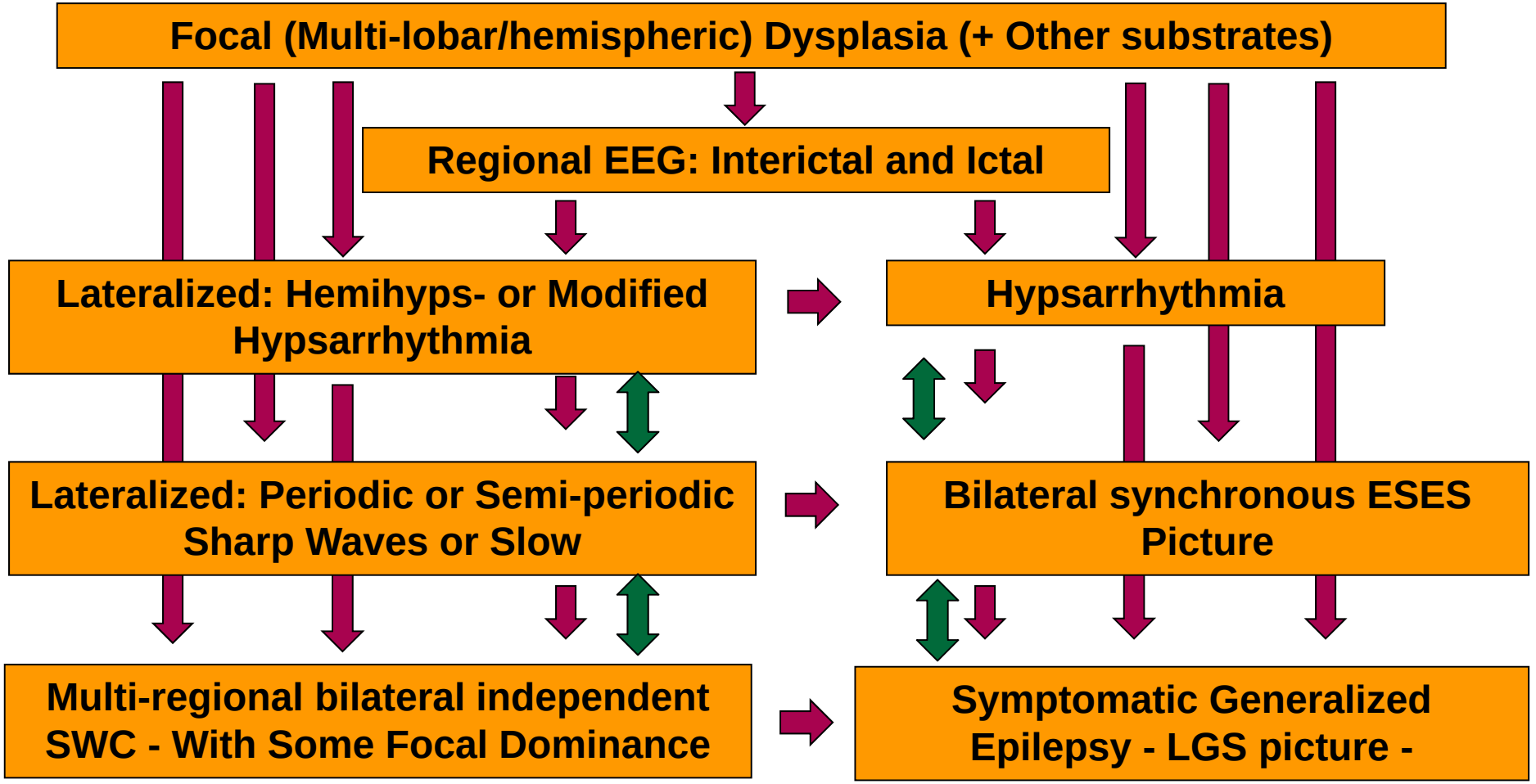
- Basic pre-surgical screening tools:
  - Clinical evaluation & seizure semiology
  - Scalp VEEG
  - Brain MRI
- We will discuss unique characteristics in the developmental context to interpret basic pre-surgical screening tools

VEEG: Development of Epileptic Encephalopathy

- In some children, uncontrolled partial seizures over time are masked by
  - Hypsarrhythmia - infantile spasms
  - Lennox Gastaut phenotype
  - Generalized synchronous or multiregional interictal abnormalities and ictal onset
- On review, VEEG does NOT provide any evidence for a partial epilepsy

Gupta A et al., Pediatric Neurology 2007:37; 8-15

“Progressively Worse” EEG Patterns



Based on retrospective surgical series: A. Seizure freedom B. Resolution of Progressive EEG patterns

Cleveland Clinic

Summary: published Pediatric epilepsy surgery series

VEEG: In-depth Analysis

- Expected normal for the age
- Asymmetric physiologic elements
- Asymmetric slow - continous
- Asymmetric spasms or tonic seizures
- Nonclinical partial seizures
- Unrecognized clinical partial seizures
- Partial seizures buried in the cluster of spasms or tonic seizures
  - Not necessarily at the onset of cluster
- Earlier EEGs (longitudinal assessment)

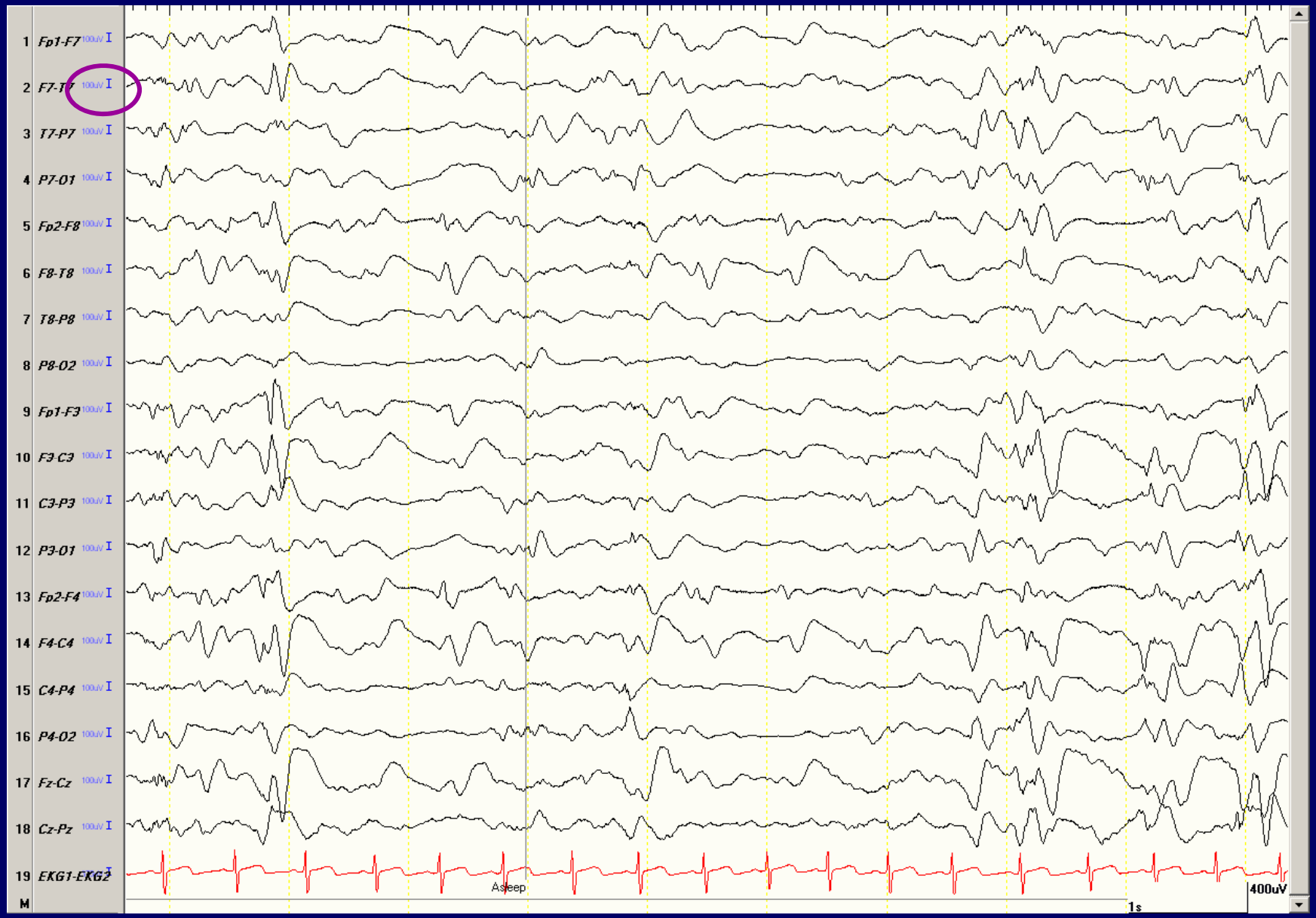
Gupta A et al., Pediatric Neurology 2007:37; 8-15

Two Illustrative Cases

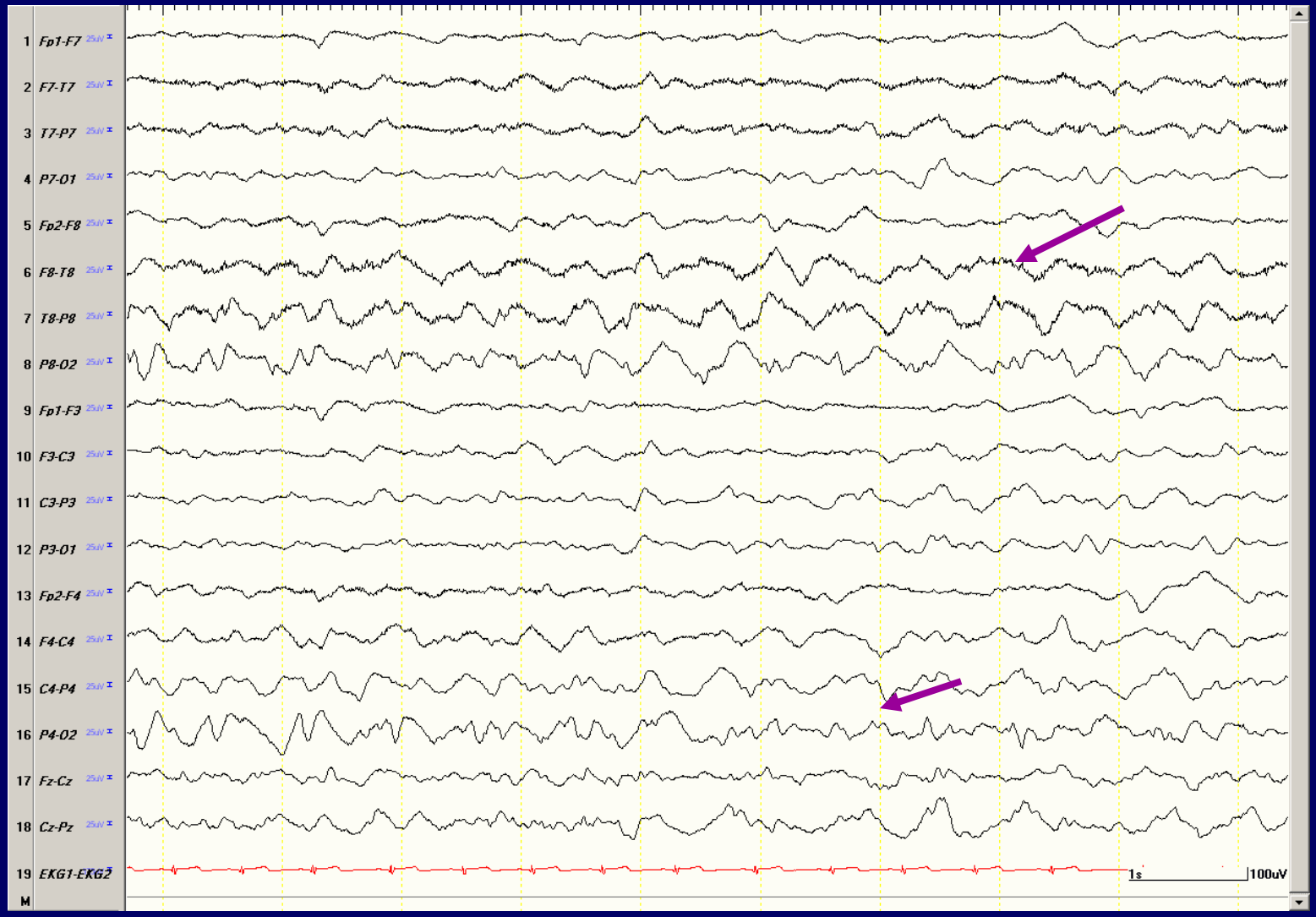
Hypsarrhythmia – West Syndrome

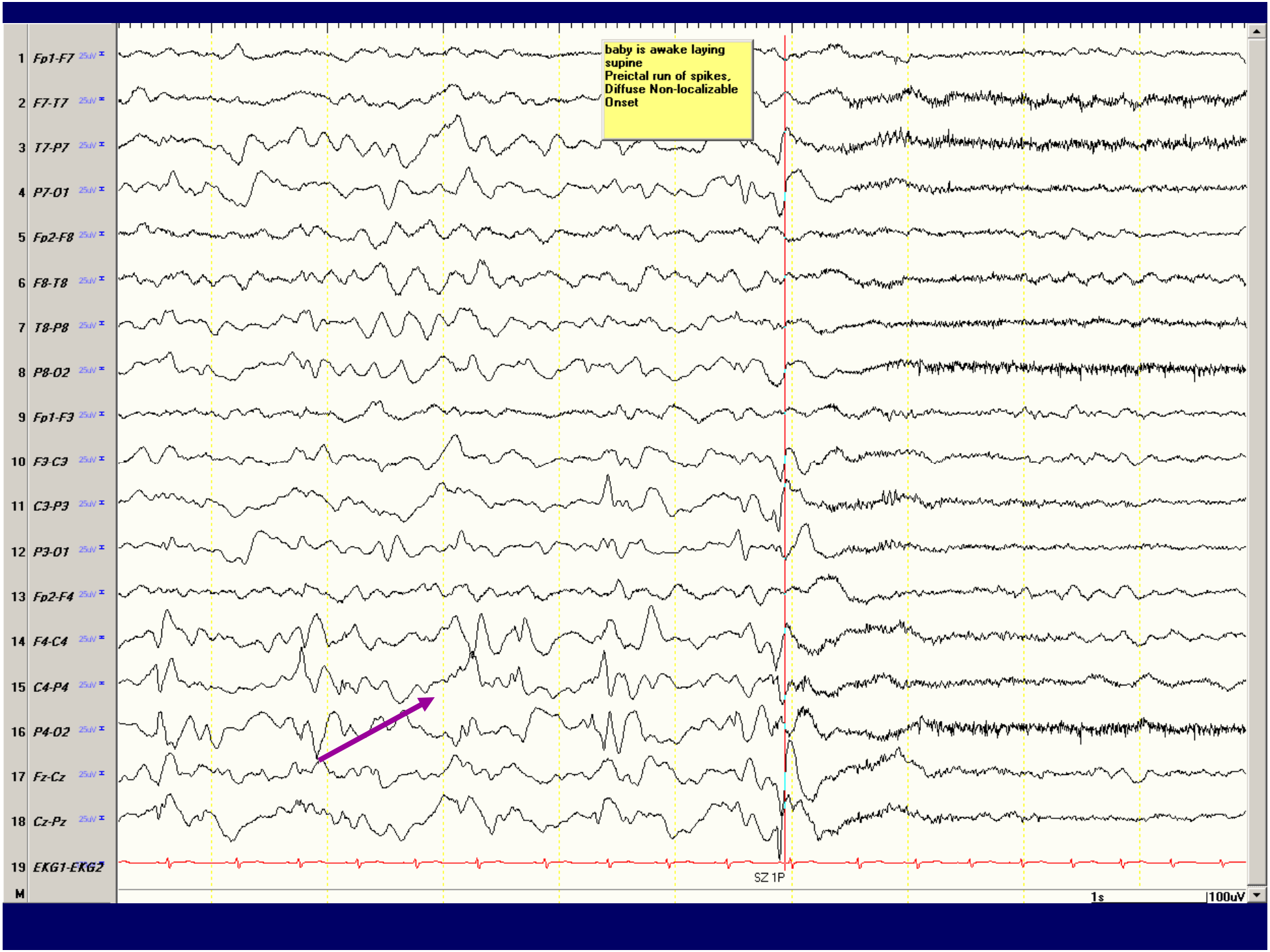
- 24 months old, female
- Hypomotor seizures -> Spasms
  - Onset of spasms at 6 months
  - Hypomotor, behavior arrest, then cluster of spasms, 5-15 times in a day
- Ambulatory, bright affect, no spoken language
- No motor deficits

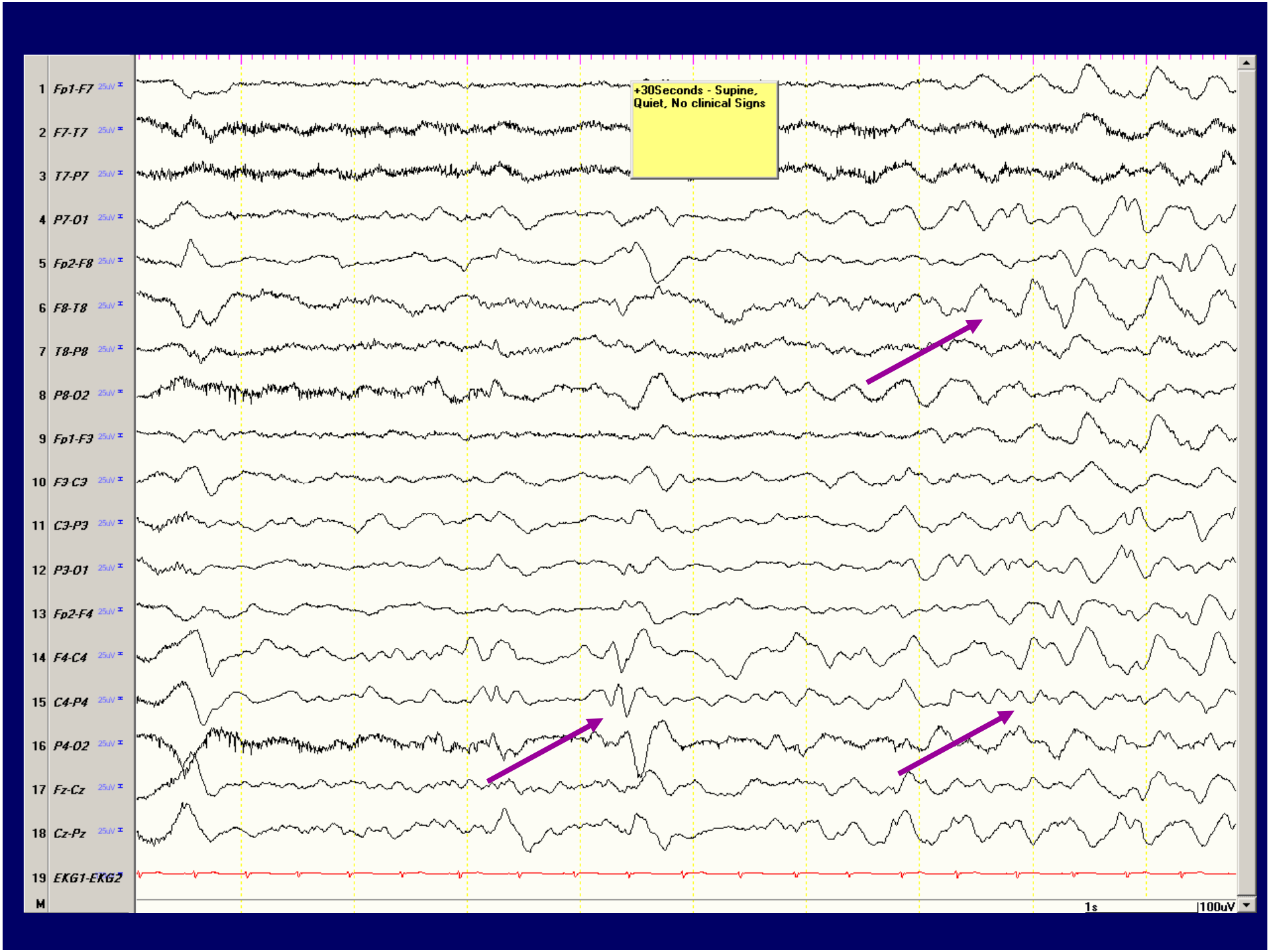
Hypsarrhythmia

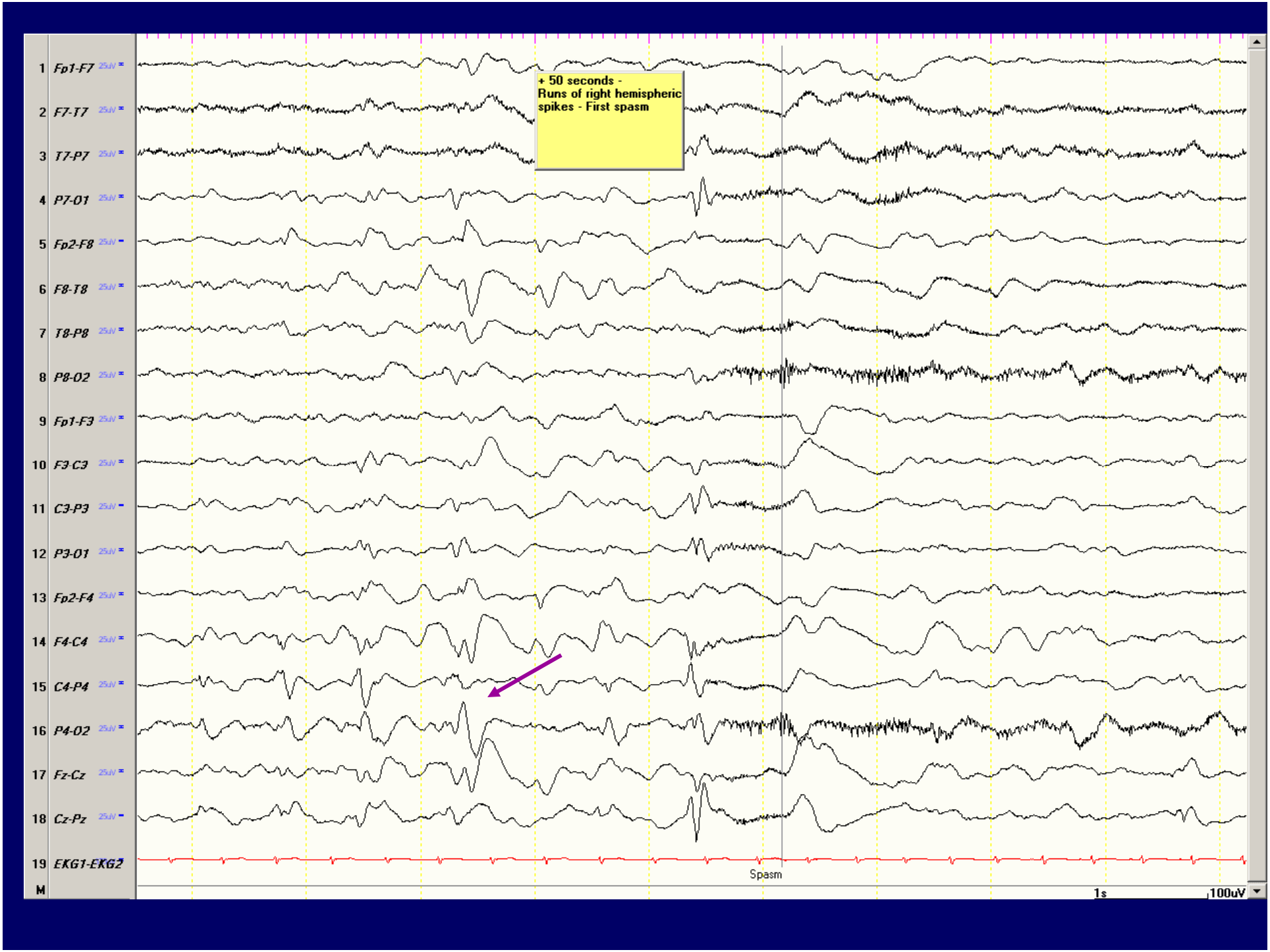


R Hemispheric SW & Slow buried in Hypsarrhythmia

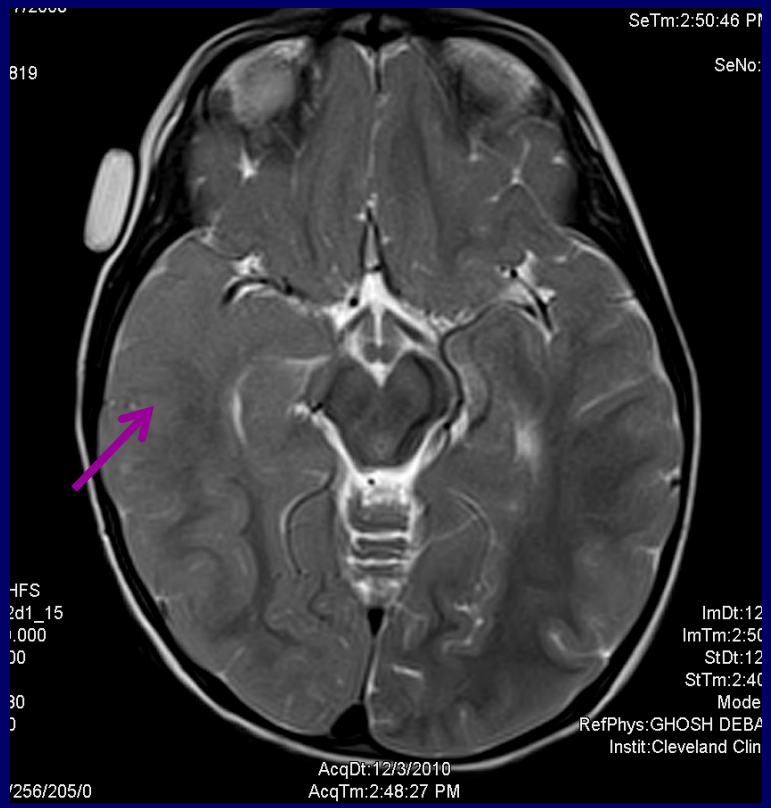


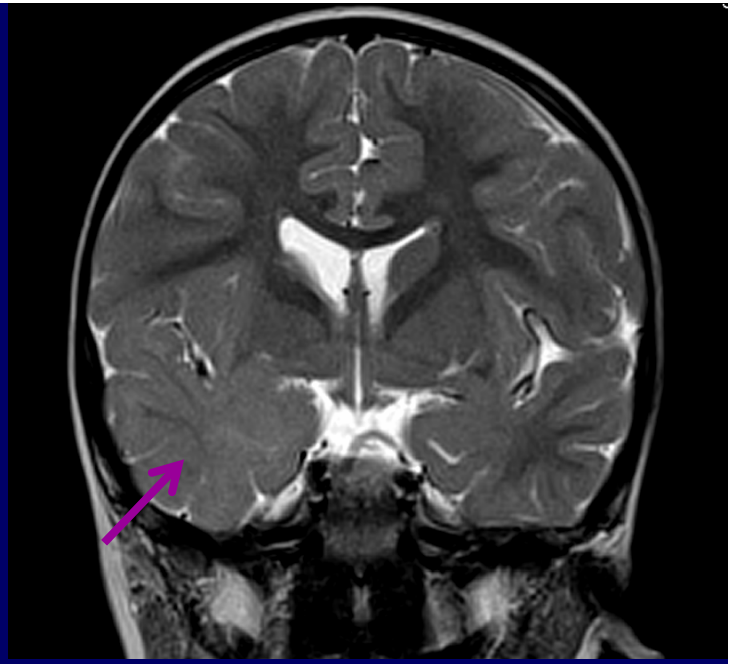

baby is awake laying supine
Preictal run of spikes, Diffuse Non-localizable Onset
1 Fp1-F7
2 F7-T7
3 T7-P7
4 P7-O1
5 Fp2-F8
6 F8-T8
7 T8-P8
8 P8-O2
9 Fp1-F3
10 F3-C3
11 C3-P3
12 P3-O1
13 Fp2-F4
14 F4-C4
15 C4-P4
16 P4-O2
17 Fz-Cz
18 Cz-Pz
19 EKG1-EKG2
M
SZ 1P
1s
100uV

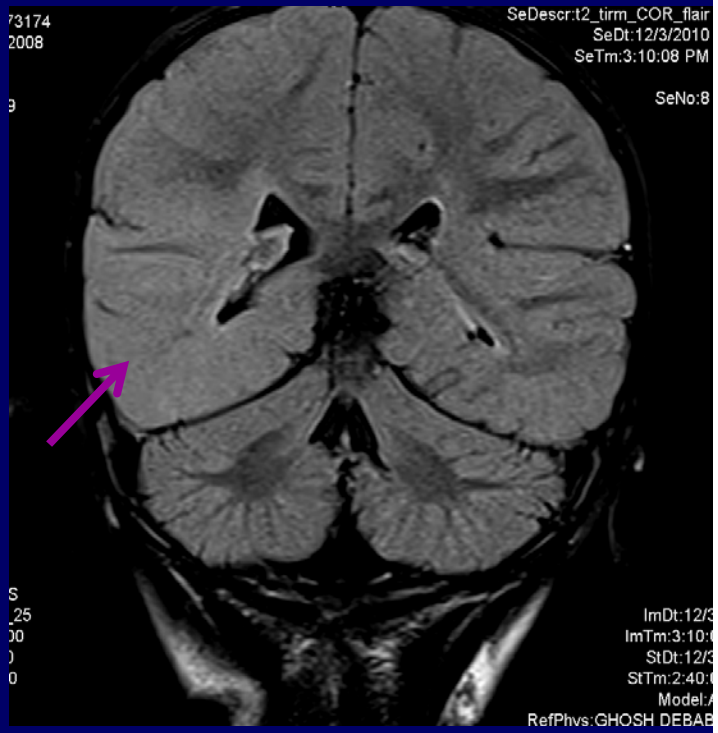

+30Seconds - Supine, Quiet, No clinical Signs
1 Fp1-F7
2 F7-T7
3 T7-P7
4 P7-O1
5 Fp2-F8
6 F8-T8
7 T8-P8
8 P8-O2
9 Fp1-F3
10 F3-C3
11 C3-P3
12 P3-O1
13 Fp2-F4
14 F4-C4
15 C4-P4
16 P4-O2
17 Fz-Cz
18 Cz-Pz
19 EKG1-EKG2
M
1s
100uV


1 Fp1-F7 25uV
2 F7-T7 25uV
3 T7-P7 25uV
4 P7-O1 25uV
5 Fp2-F8 25uV
6 F8-T8 25uV
7 T8-P8 25uV
8 P8-O2 25uV
9 Fp1-F3 25uV
10 F3-C3 25uV
11 C3-P3 25uV
12 P3-O1 25uV
13 Fp2-F4 25uV
14 F4-C4 25uV
15 C4-P4 25uV
16 P4-O2 25uV
17 Fz-Cz 25uV
18 Cz-Pz 25uV
19 EKG1-EKG2
M
+ 50 seconds -
Runs of right hemispheric
spikes - First spasm
Spasm
1s
100uV

Brain MRI – Right Temporo-Occipital Malformation



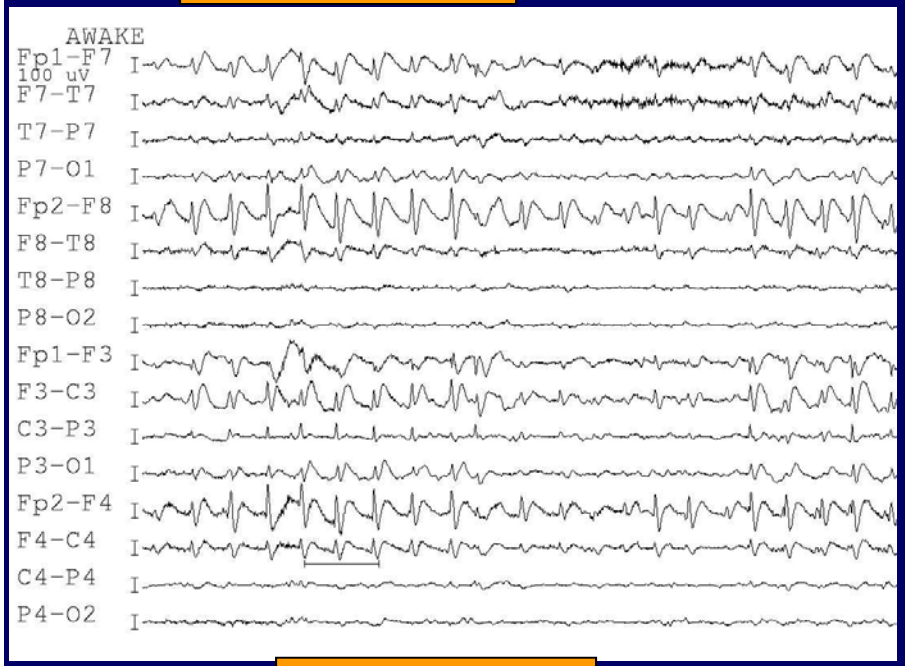




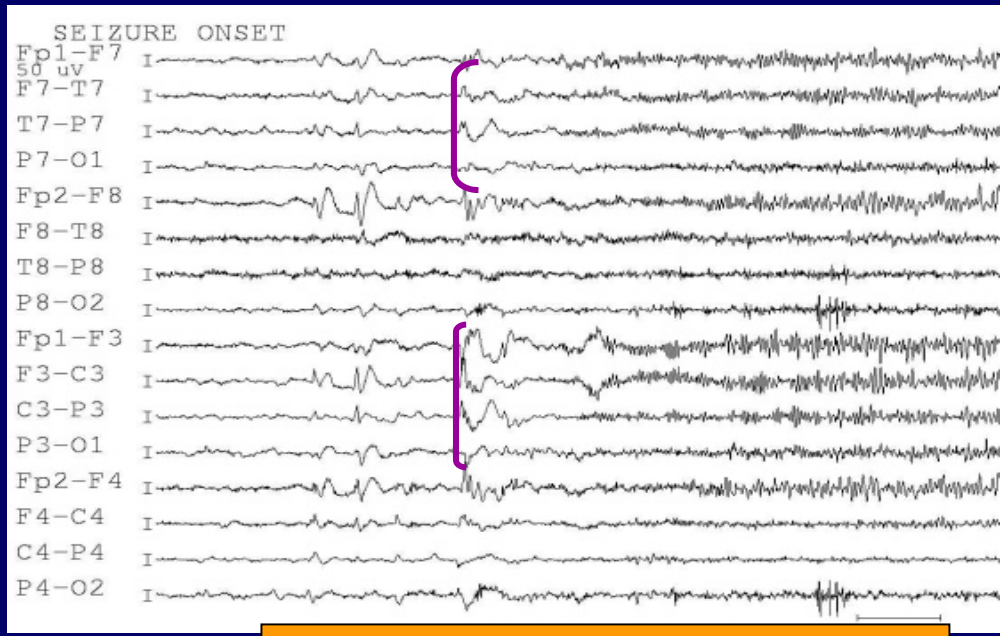
13 year-old: Lennox Gastaut syndrome

- Seizure onset 8 weeks of life
  - Multifocal clonic seizures during acute meningo-encephalitis
- Since 3 months of age
  - Axial Tonic Seizures with falls, 4-5 per day
  - Failed almost all medications
- Exam:
  - Severe cognitive delay and severe left hemiparesis

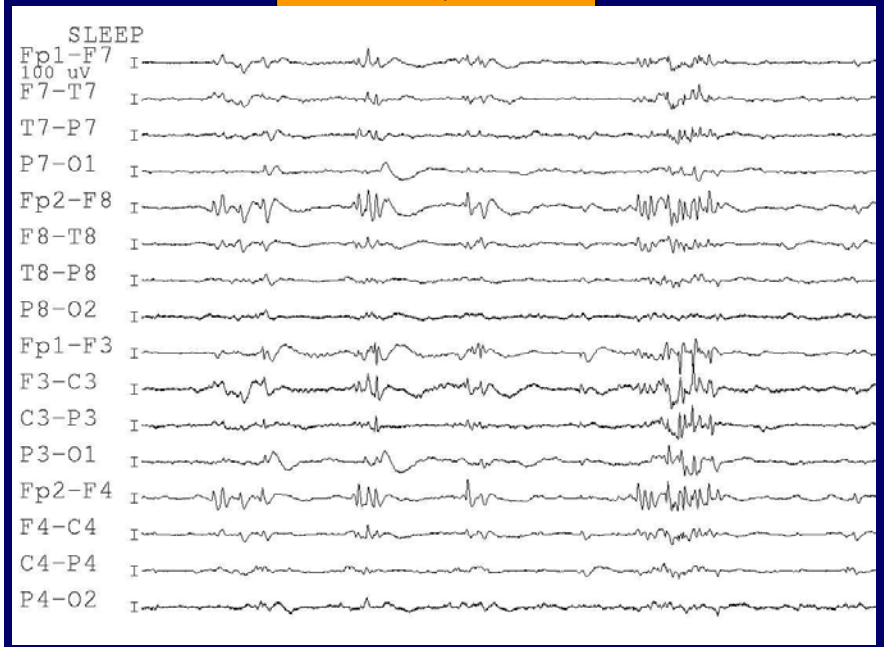
SSWC: R>L



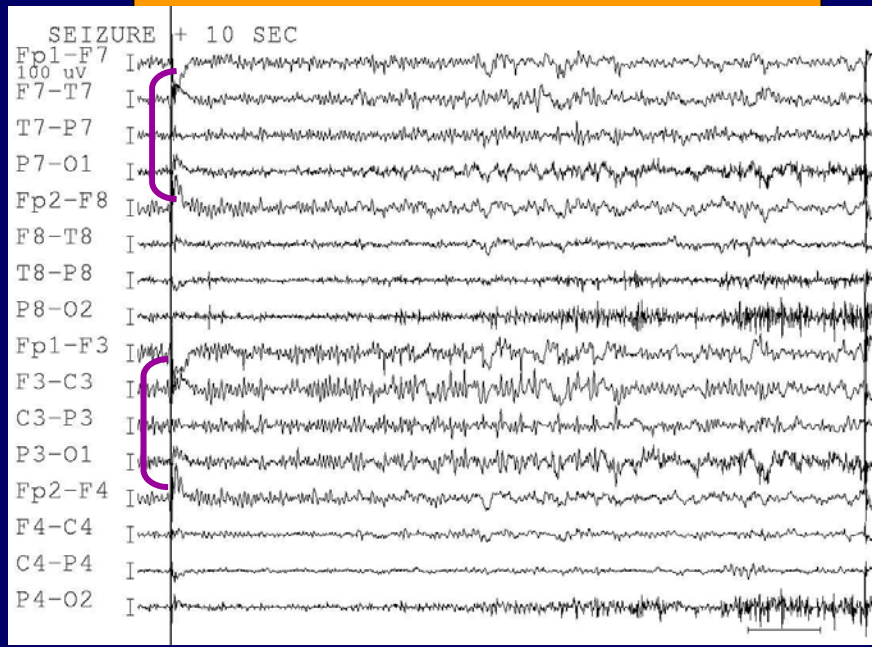
Ictal Onset – Tonic seizure



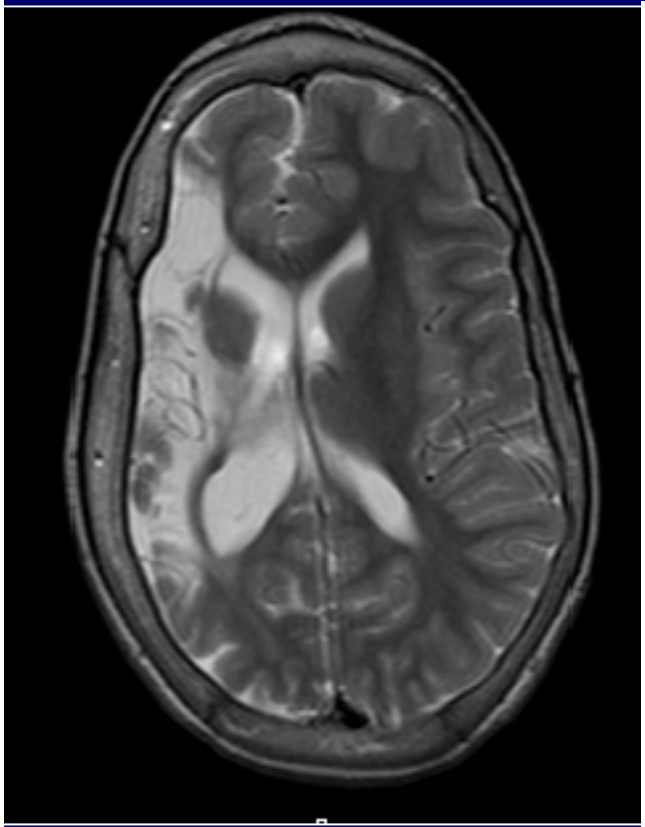
SSWC; NCS



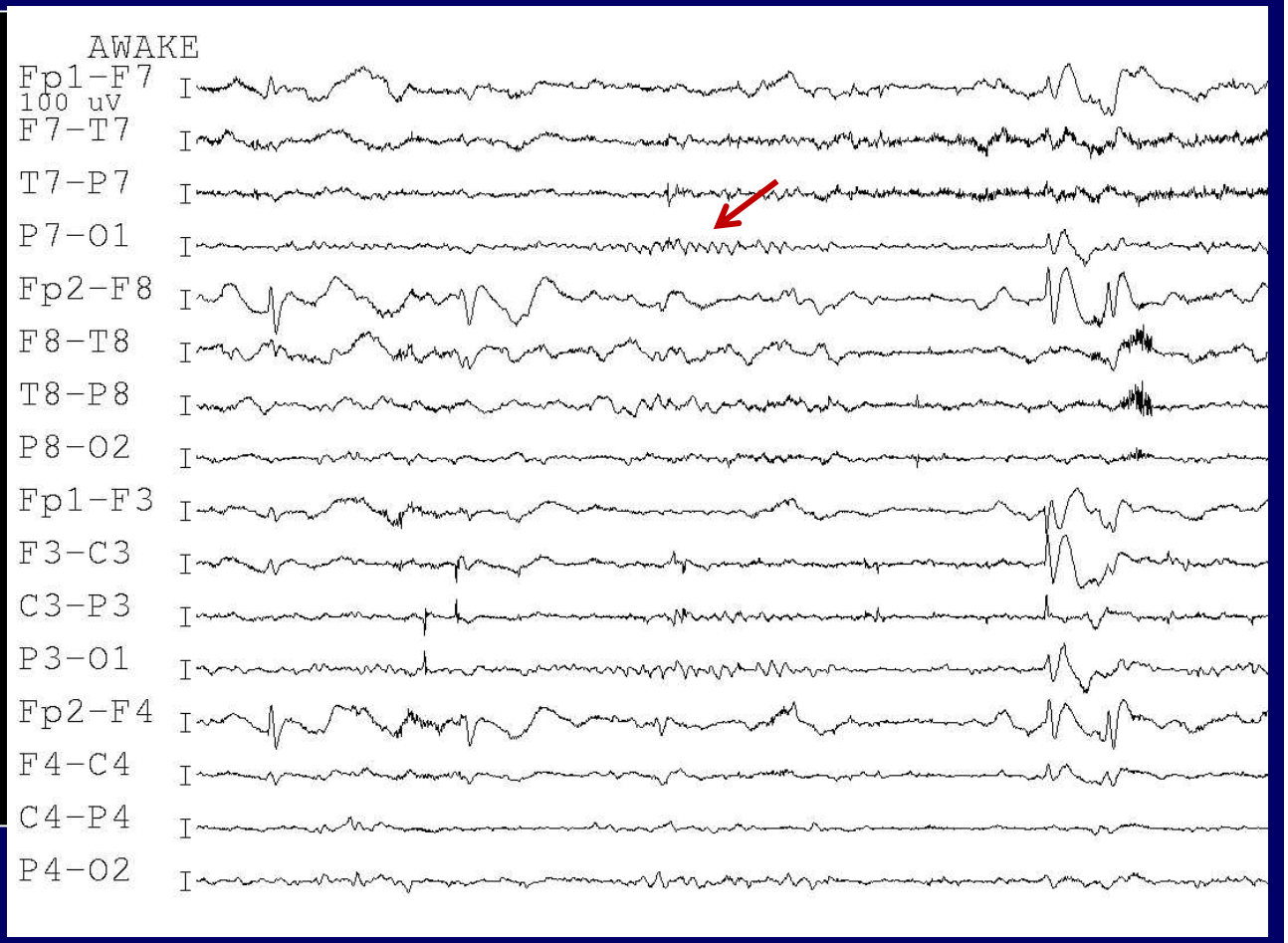
Ictal Onset + 10 seconds



Pre-operative Brain MRI



EEG After Right Disconnective Hemispherectomy



Original article

Epileptic Disord 2009; 11 (3): 215-21

Paradoxical ictal EEG lateralization in children with unilateral encephaloclastic lesions

Eliana Garzon[1], Ajay Gupta[2], William Bingaman[2], Americo C. Sakamoto[1], Hans Lüders[3]

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[2] Epilepsy Center, Neurological Institute, Cleveland Clinic Foundation, Cleveland, Ohio
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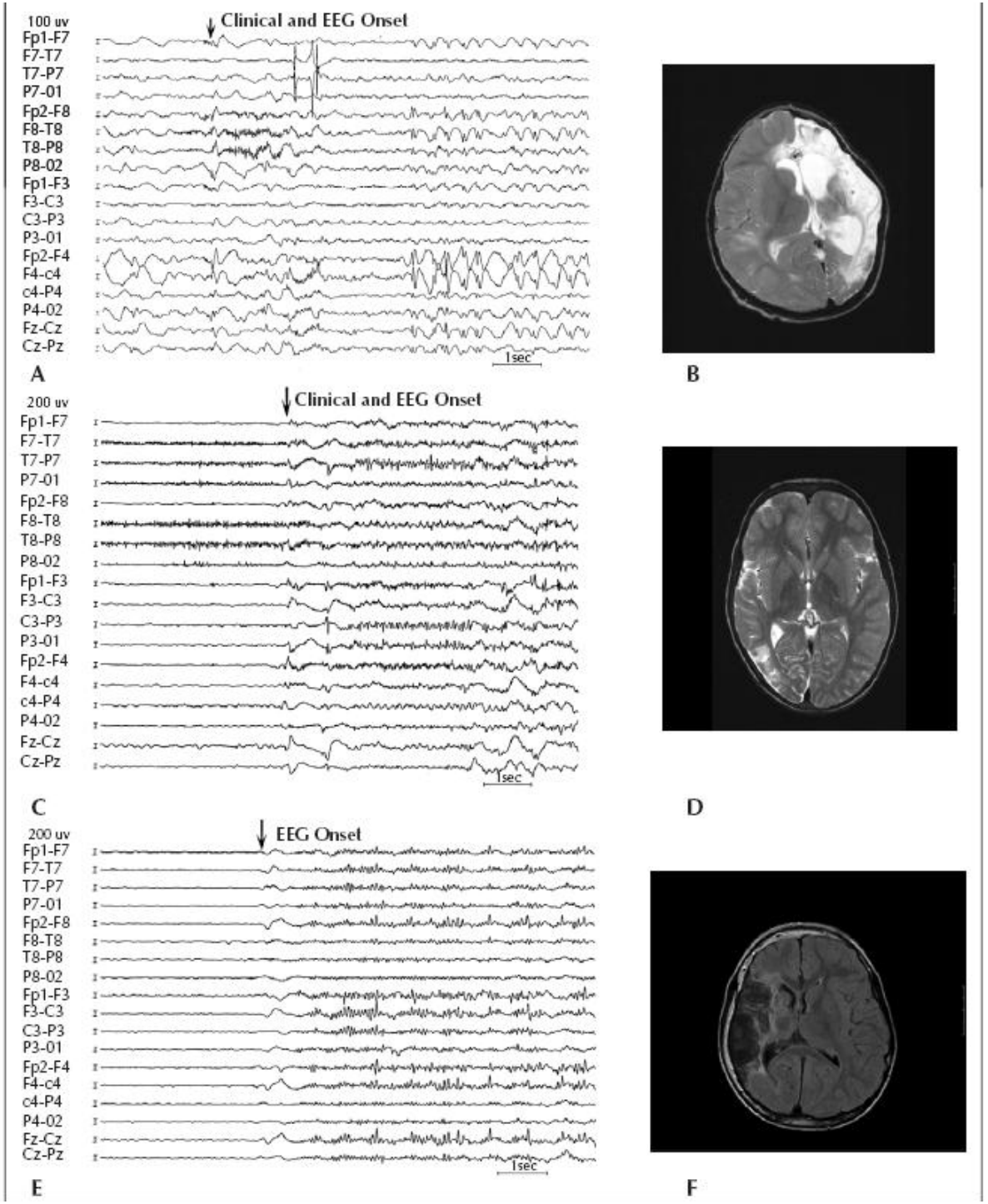
Received February 21, 2009; Accepted July 8, 2009

- **In unilateral encephaloclastic lesion, ictal EEG onset and early ictal spread may falsely lateralize to the "good hemisphere"**

- **Such interictal and ictal EEG patterns do not contradict benefit from epilepsy surgery provided other findings are concordant for epileptogenicity in the abnormal hemisphere**

Paradoxical Lateralization of ictal EEG – is not lesion location or size related

Garzon et al., Epileptic Disorders 2009; 11: 215-21



ELSEVIER

Original Articles

Pediatric Epilepsy Surgery in Focal Lesions and Generalized Electroencephalogram Abnormalities

Ajay Gupta, MD, Adina Chirla, RN, Elaine Wyllie, MD, Deepak K. Lachhwani, MD, Prakash Kotagal, MD, and William E. Bingaman, MD

Initial surgeries were done in desperate children and families who were at or near the end of their medical treatment

This is now a well recognized consequence of early onset epilepsy

Gupta A et al., Pediatric Neurology 2007:37; 8-15

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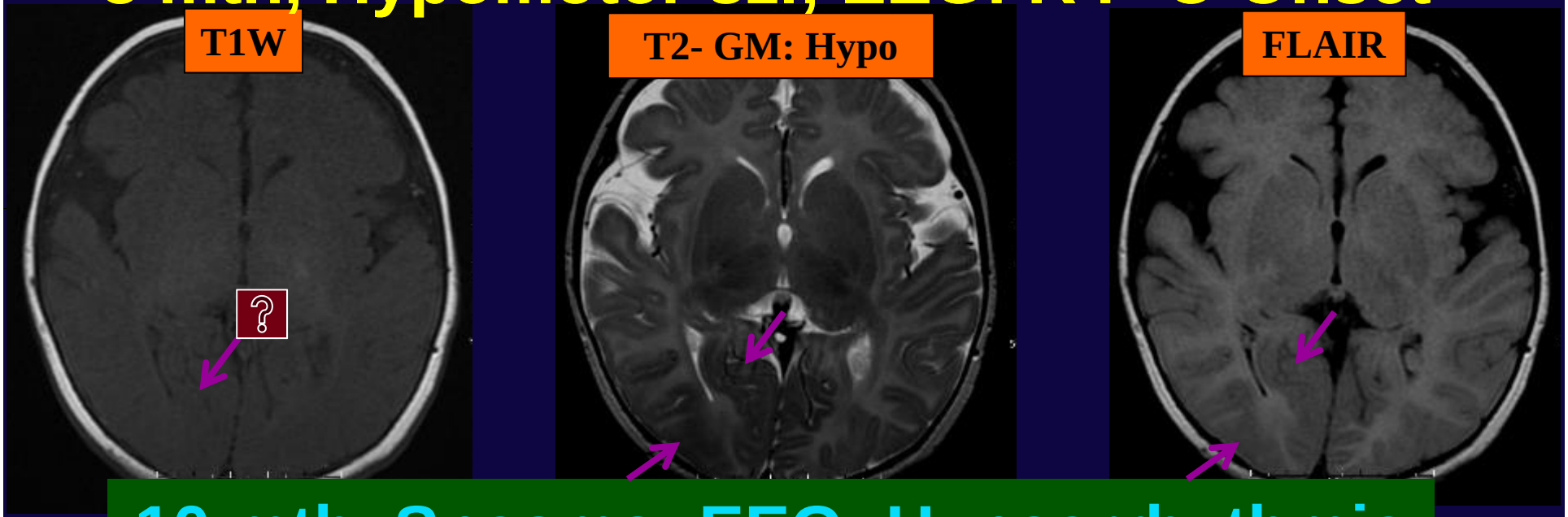
Brain MRI: FCD Changes

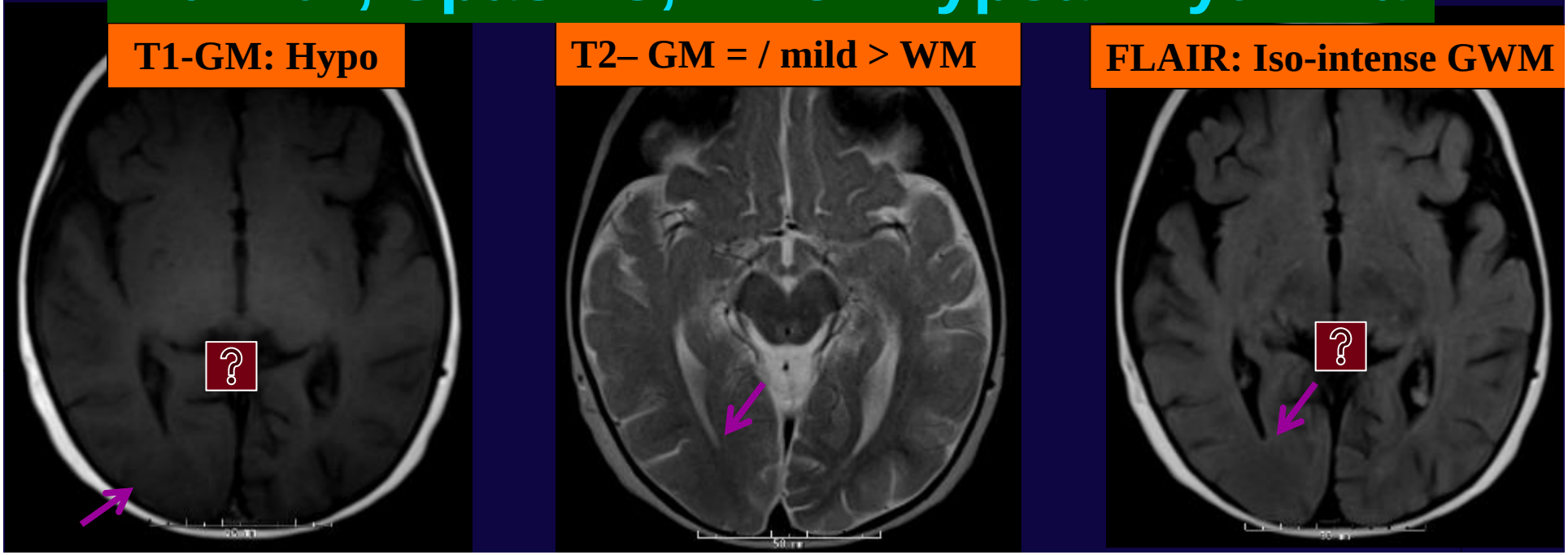
- Age appropriate MRI protocol in Infants/young children
- MRI characteristics of FCD may change from birth to 2-3 years age
- Lesions may **dis**appear and **re**appear with different signal characteristics
- MRI lesions not seen "unfavorable window" – 6 mon – 2 yr – **Repeat study**
  - FDG-PET may help during this period

Gaillard et al., Epilepsia 2009; 50: 2147-50

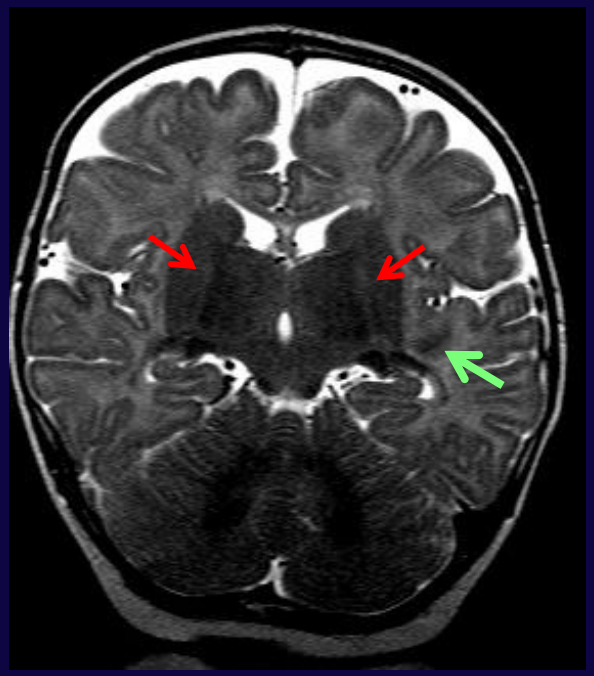
3 mth, Hypomotor sz.; EEG: R P-O Onset



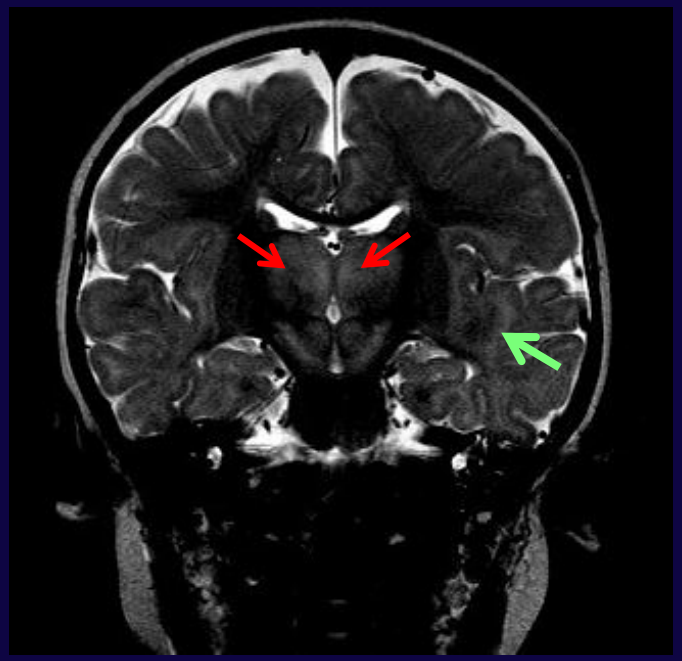
10 mth, Spasms; EEG: Hypsarrhythmia



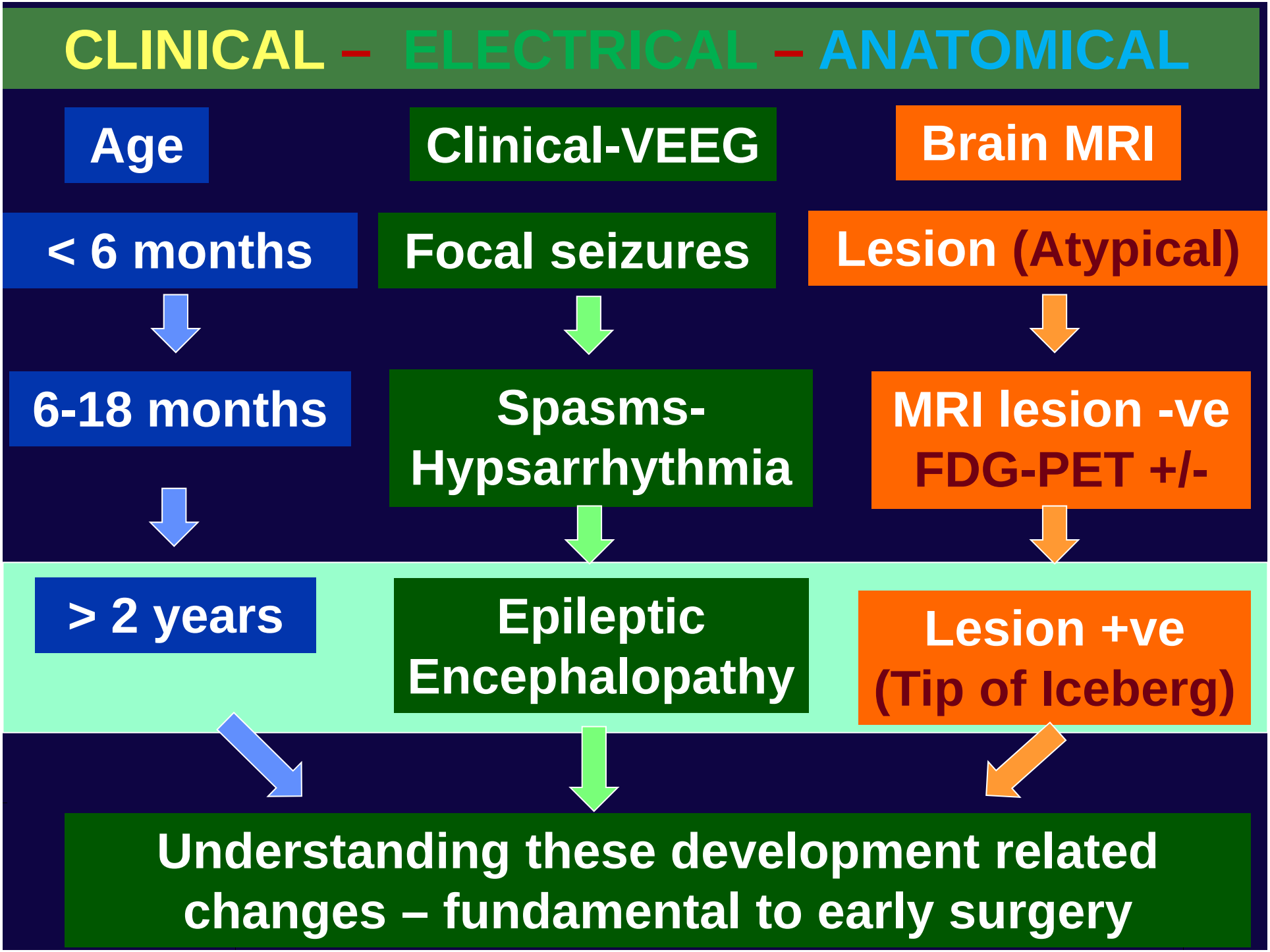
Review of First Brain MRI Critical



- 4 month old
- Left temporal seizures + Hypsarrhythmia
- Before VGB, ACTH



- 9 month old, male
- Infantile spasms
- EEG: Left temporal sz + Hypsarrhythmia
- ACTH, VGB


CLINICAL – ELECTRICAL – ANATOMICAL
Age
Clinical-VEEG
Brain MRI
< 6 months
Focal seizures
Lesion (Atypical)
6-18 months
Spasms-Hypsarrhythmia
MRI lesion -ve FDG-PET +/-
> 2 years
Epileptic Encephalopathy
Lesion +ve (Tip of Iceberg)
Understanding these development related changes – fundamental to early surgery

Conclusions

- **Pre-surgical tools in children requires understanding of age related unique factors**
- **Clinical-electrographic-anatomical (MRI) findings are variable, development dependent, and change with age**
  - **Such features are likely expression of "developmental immaturity and transforming brain connectivity"**

THANK YOU

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