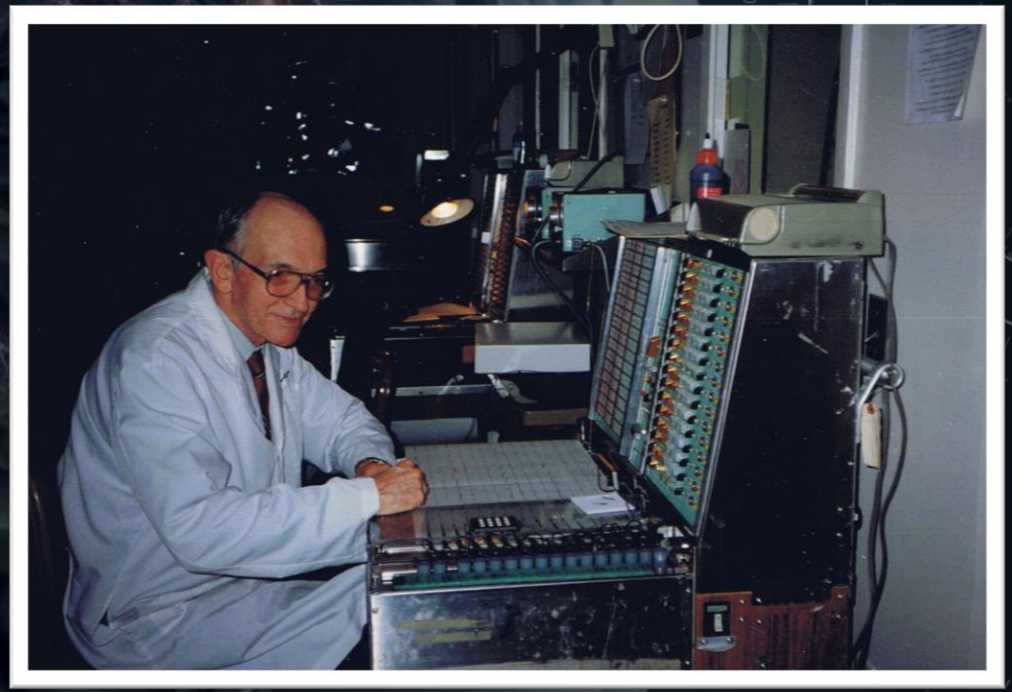
NOCTURNAL SEIZURES

COLIN MASSICOTTE RPSGT

NOVEMBER 3, 2018 11:30AM-12:15PM

NOT A LEARNING OBJECTIVE

- To become an EEG expert – this takes months, years of practice



Electroencephalography is like a beautiful park with a sign posted at the entrance: "For Persons with Total Commitment only" – Ernst Niedermeyer, MD (1920-2012)

AJET Vol.24, #2, June 1984, p.72

LEARNING OBJECTIVES

- Learn basic nomenclature related to seizure activity
- Recognize abnormal EEG activity
- Be able to respond to patient having a seizure in the sleep lab safely

PRIESTESS OF DELPHI (1891)

John Collier, Art Gallery of South Australia

A Bittersweet Story: The True Nature of the Laurel of the Oracle of Delphi. Haralampos V. Harissis. Perspectives in Biology and Medicine, Volume 57, Number 3, Summer2014, pp. 351-360 (Article). Published by Johns Hopkins University Press

THE SACRED DISEASE

- Epilepsy known the “sacred disease” in antiquity
- prevailed for many centuries even after Hippocrates expressed his opposition to this widespread belief in his work On the Sacred Disease (5th C. BCE)
- Aristotle considered sleep “as an epilepsy”

A Bittersweet Story: The True Nature of the Laurel of the Oracle of Delphi. Haralampos V. Harissis. Perspectives in Biology and Medicine, Volume 57, Number 3, Summer2014, pp. 351-360 (Article). Published by Johns Hopkins University Press

WHAT IS A SEIZURE? WHAT IS EPILEPSY?

- Seizures are changes in awareness or behavior brought about by an abnormal discharge of electrical activity in the brain
- Epilepsy is the tendency toward recurrent, unprovoked seizures

Kids & Seizures: Know the Hidden Signs. Epilepsy Foundation fo America. 2008. www.epilepsyfoundation.org
St. Louis, EK. Sleep and Epilepsy: Strange Bedfellows No More. Minerva Pneumol. 2011 Sep; 50(3): 159–176.

EPILEPSY

- background EEG is usually normal in patients with epilepsy
- abnormal interictal EEG manifestations may include non-epileptiform abnormalities and interictal epileptiform discharges (IEDs)
- Patients with epilepsy may show generalized or focal slowing of the background, but most useful diagnostic finding supportive of a diagnosis of epilepsy is the activation of IEDs, which may be either focal or generalized
- IEDs must be carefully distinguished from benign variants, artifact or normal brain waves to avoid over-interpretation

Electroencephalography (EEG): An Introductory Text and Atlas of Normal and Abnormal Findings in Adults, Children, and Infants [Internet]. Britton JW, Frey LC, Hopp JLet al., authors; St. Louis EK, Frey LC, editors. Chicago: American Epilepsy Society; 2016.

EPILEPSY AND SLEEP

- 7.5 to 45 percent of people who have epilepsy have seizures mostly during sleep
- Sleep disorders more prevalent in epileptic population
- Nocturnal seizures usually occur towards the end of the sleep period (5am to 6am)
- Chances of capturing seizure in lab are low, even in patients with known epilepsy

Thomas RH, King WH, Johnston JA, et al Awake seizures after pure sleep-related epilepsy: a systematic review and implications for driving law Journal of Neurology, Neurosurgery & Psychiatry 2010;81:130-135.

Al-Biltagi MA. Childhood epilepsy and sleep

WHY MAY SEIZURES HAPPEN IN SLEEP?

- Epileptic seizures are often strongly influenced by the sleep-wake cycle
- change of state has effect on the brain's epileptic activity; nocturnal seizures are triggered by changes in the electrical activity in your brain when moving between the different stages of sleep, and between sleep and wake

https://www.epilepsy.org.au/about-epilepsy/understanding-epilepsy/nocturnal-seizures-seizures-during-sleep/

NREM

- occurrence of generalized discharges and clinical seizures mainly in NREM sleep, most IEDs in SWS
- can enhance IEDs in both focal and generalized seizures
- seizure activating role of NREM sleep has been attributed to increased neuronal synchronization within thalamo-cortical projection neurons with robust activation of epileptic ictal and interictal activity
- Most sleep-related seizures start during N2
- few seizures occur during N3 slow wave sleep (SWS)

REM

- REM sleep limits spread of epileptic discharges outside the area that started seizure activity
- Few/no seizures in stage R

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St. Louis EK. Sleep and Epilepsy: Strange Bedfellows No More. Minerva Pneumol. 2011 Sep; 50(3): 159–176.

St. Louis EK. Sleep and Epilepsy: Strange Bedfellows No More. Minerva Pneumol. 2011 Sep; 50(3): 159–176.

HOW TO RECOGNIZE A SEIZURE

- Short attention blackouts that look like daydreaming, Dazed behavior
- Sudden falls for no reason
- Lack of response for brief periods
- Unusual sleepiness and irritability when wakened from sleep
- Head nodding
- Rapid blinking
- Frequent complaints from the child that things look, sound, taste, smell or feel “funny.”
- Clusters of “jackknife” movements by babies who are sitting or laying down
- Clusters of grabbing movements with both arms in babies lying on their backs
- Sudden stomach pain followed by confusion and sleepiness
- Repeated movements that look out of place or unnatural

- A blank stare, followed by chewing, picking at clothes, mumbling, random movements
- Sudden fear, anger, or panic for no reason
- Muscle jerks of arms, legs, or body, especially in the early morning
- Odd changes in the way things look, sound, smell or feel
- Memory gaps
- Dazed behavior
- Being unable to talk or communicate for a short time

Kids & Seizures: Know the Hidden Signs. Epilepsy Foundation of America. 2008. www.epilepsyfoundation.org

HOW TO RECOGNIZE SEIZURE ON EEG – CAN BE CHALLENGING FOR SLEEP TECHS

- number and placement of EEG electrodes
- experience of the sleep tech
- size and location of the ictal generator
- paper speed

Foldvary N, Cosmo Caruso A, Mascha E, Perry M, Klem G, McCarthy V, Qureshi F, Dinner D. Identifying Montages that Best Detect Electrographic Seizure Activity During Polysomnography. SLEEP, Vol. 23, No. 2, 2000

HOW TO DESCRIBE WHAT YOU SEE

- Frequency
- Localization
- Amplitude
- Variability

Noachtar S. How to approach EEG and avoid overreading in epilepsy

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Noachtar S. How to approach EEG and avoid overreading in epilepsy

DEFINITIONS

- **Interictal epileptiform discharges (IEDs)**
- EEG isolated spikes, or sharp waves or spike-wave complexes
- no behavioural change

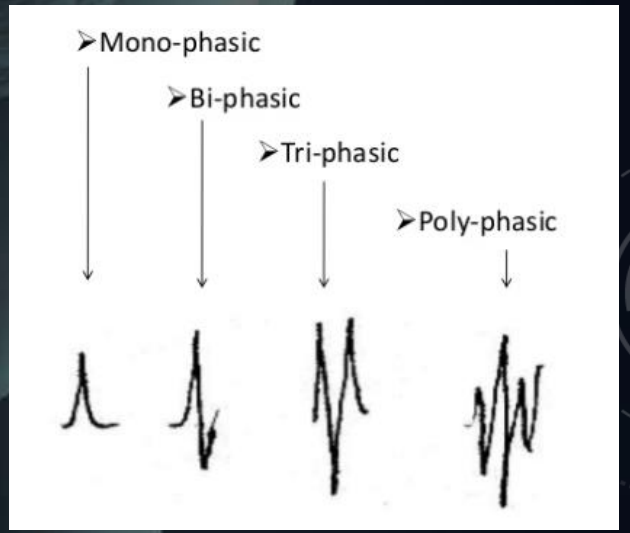
- **Ictal**
- EEG contains spikes and sharp waves lasting seconds/minutes
- usually clinical seizure

American Clinical Neurophysiology Society Standardized Critical Care EEG Terminology: 2012 version

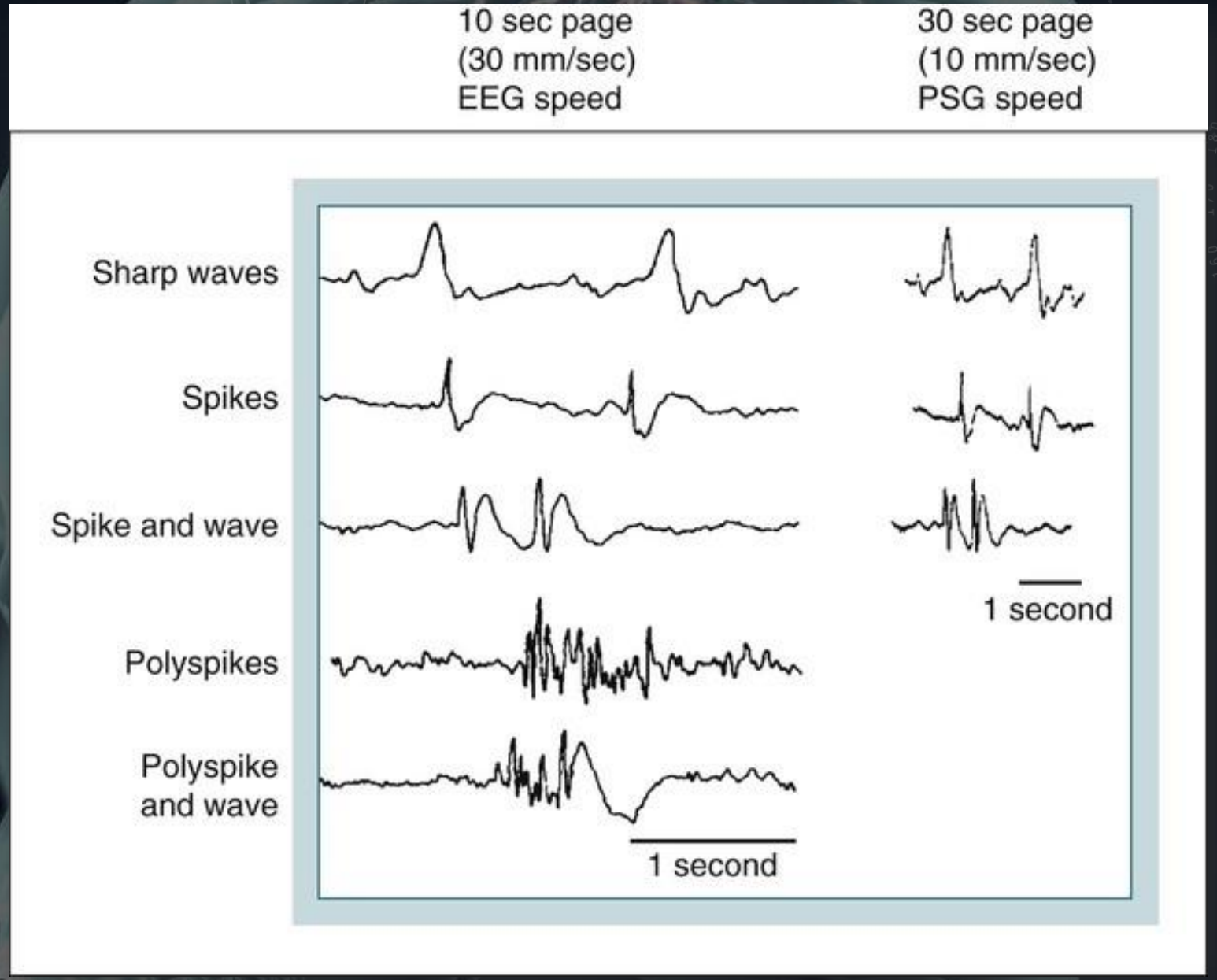
WHAT IS A SPIKE?

- Epileptogenic waves are made up of spike waves and sharp waves
- spike wave = 20-70 ms while
- sharp waves duration 70-200 ms
- Usually negative (up in PSG)

1s



Epilepsy & Behavior 25(1):137 · July 2012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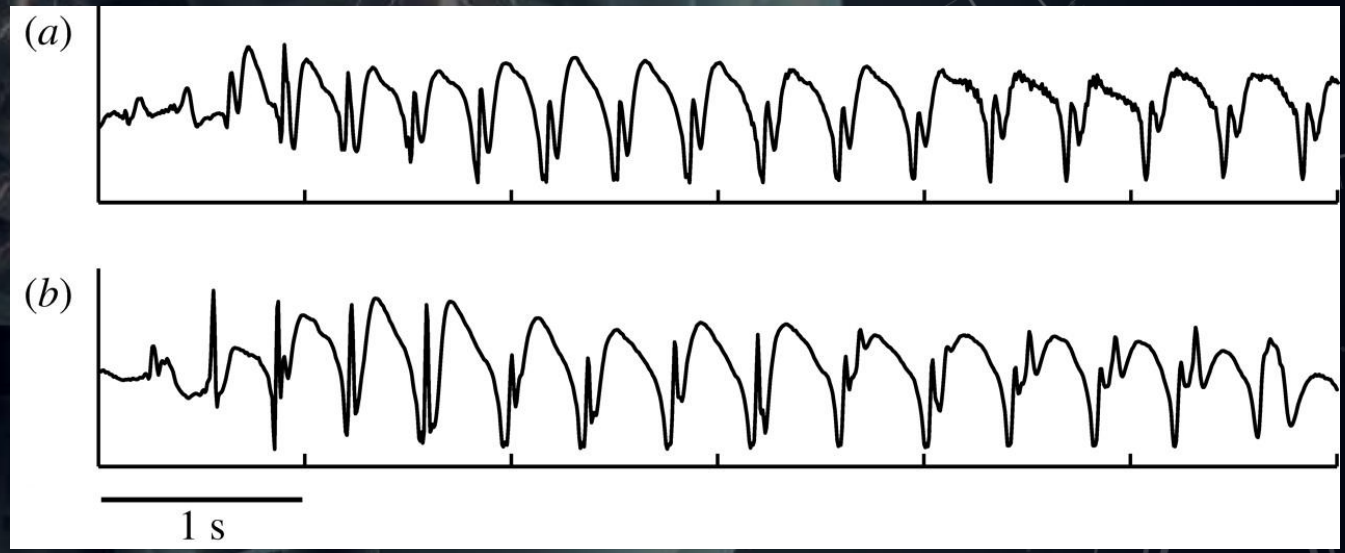
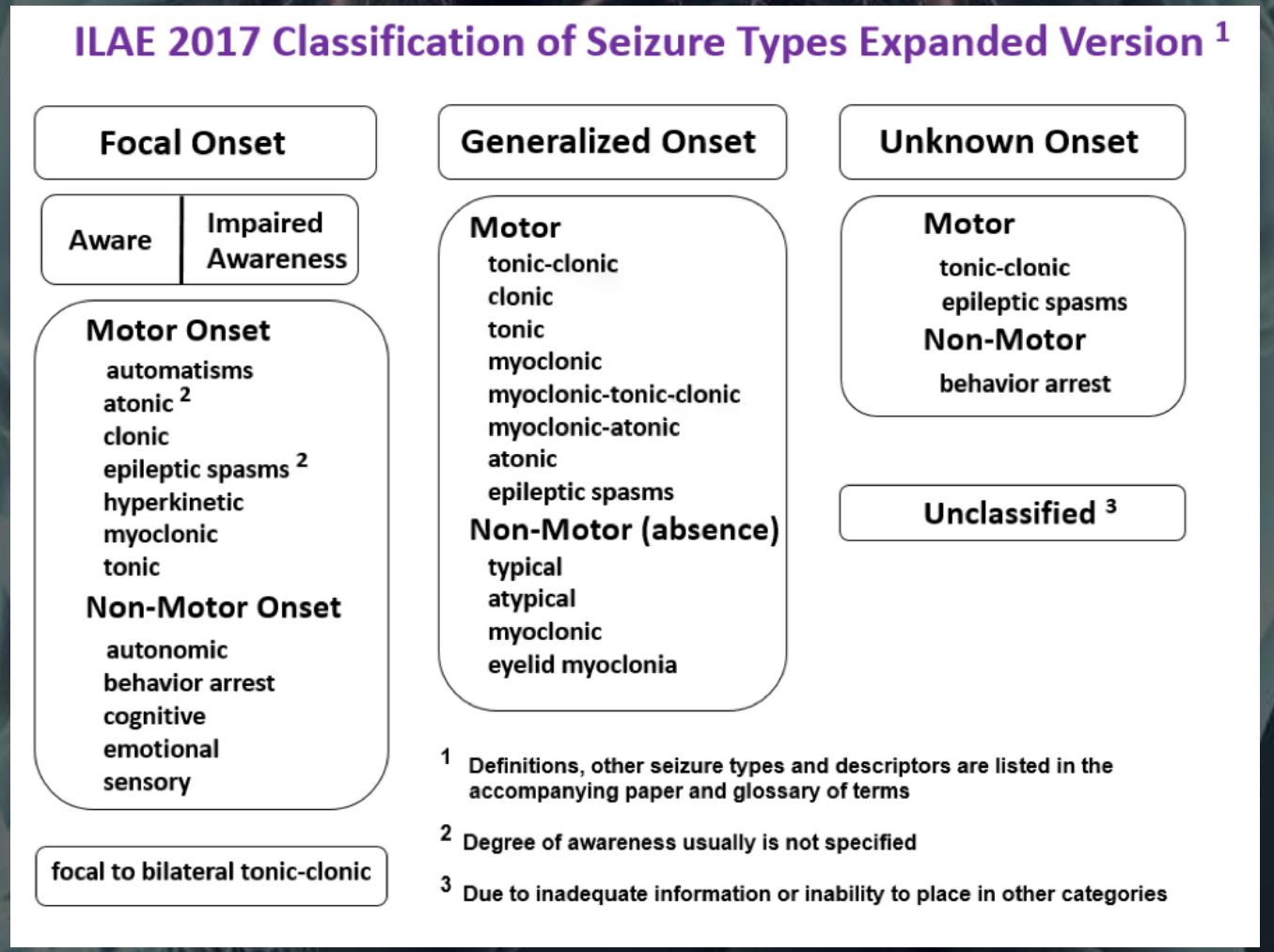
EEG speed
30 sec page
(10 mm/sec)
PSG speed
Sharp waves
Spikes
Spike and wave
Polyspikes
Polyspike
and wave
1 second
1 second

WHAT IS A SPIKE AND WAVE?

- 2 different patients with childhood absence epilepsy
- (a) A typical spike–wave oscillation (3Hz)
- (b) additional spikes may be seen



CLASSIFICATION - INTERNATIONAL LEAGUE AGAINST EPILEPSY



ADVANTAGE OF PSG EEG

- interictal epileptiform discharges (IEDs) most sensitive and specific markers for seizure diagnosis
- routine EEG studies, which typically record for only 20–30 min
- routine EEG chance of recording clinical seizure is rare, IEDs are important
- Longer, ambulatory EEG studies do not provide sufficient information regarding whether a potential sleep disorder is present due to lack of respiratory and electromyography (EMG) channels

Beyond standard polysomnography: Advantages and indications for use of extended 10–20 EEG montage during laboratory sleep study evaluations. Bubrick EJ, Yazdani S, Pavlov MK. Seizure, Volume 23, Issue 9, October 2014, Pages 699-702

Chapter 4: EEG Interpretation in Childhood Epilepsies
Charuta N. Joshi, Thoru Yamada in Clinical Neurophysiology in Pediatrics: A Practical Approach to Neurodiagnostic Testing and Management by Gloria M. Galloway

ADVANTAGE OF PSG EEG

- Seizures can be triggered by OSA which is highly prevalent among adults with epilepsy, with a prevalence rate around 40%, and is moderate-to-severe in 16%
- OSA fragments sleep and produces a state of chronic sleep deprivation (which increase seizures), one would expect a benefit from routine screening for OSA in adults with epilepsy

Somboon T, et al. Long-term seizure control in epileptic patients with obstructive sleep apnea using positive airway pressure therapy. Presented at: American Epilepsy Society Annual Meeting; Dec. 1-5; Washington, D.C

BEST MONTAGE

Practice Parameters for the Indications for Polysomnography and Related Procedures: "4.4.3.1 Polysomnography, with additional EEG derivations in an **extended bilateral montage**, and video recording, is recommended to assist with the diagnosis of paroxysmal arousals or other sleep disruptions that are thought to be seizure related when the initial clinical evaluation and results of a standard EEG are inconclusive."

- AASM PSG: Referential montage F4-M1 C4-M1 O2-M1 (backup F3, C3, O1, M2)
- advantages of limited EEG montage include reduced technical time for electrode placement, physician time for data analysis (and cost of data storage?)
- Difficult to differentiate during PSG between epileptic seizures, non-epileptic behavioral events, arousals, and artifacts
- many discharges and other EEG abnormalities focal, likely have been missed, misinterpreted, or required more evaluation if a limited EEG montage was used

Foldvary N, Cosmo Caruso A, Mascha E, Perry M, Klem G, McCarthy V, Qureshi F, Dinner D. Identifying Montages that Best Detect Electrographic Seizure Activity During Polysomnography. SLEEP, Vol. 23, No. 2, 2000.

Beyond standard polysomnography: Advantages and indications for use of extended 10–20 EEG montage during laboratory sleep study evaluations. Bubrick EJ, Yazdani S, Pavlov MK. Seizure. Volume 23, Issue 9, October 2014, Pages 699-702.

WHAT TYPES OF EPILEPSIES FEATURE SLEEP-RELATED SEIZURES?

- Juvenile Myoclonic Epilepsy (JME)
- Generalized Tonic-Clonic
- Benign Childhood epilepsy with centrotemporal spikes (BECTS) aka Benign Rolandic aka Benign Focal Epilepsy of Childhood
- Electrical Status Epilepticus of Sleep (ESES or CSWS)
- Lennox-Gastaut Syndrome
- Landau-Kleffner Syndrome (LKS)
- Frontal Onset Seizures (such as Nocturnal Frontal Lobe Epilepsy)
- Nocturnal Temporal Lobe Epilepsy

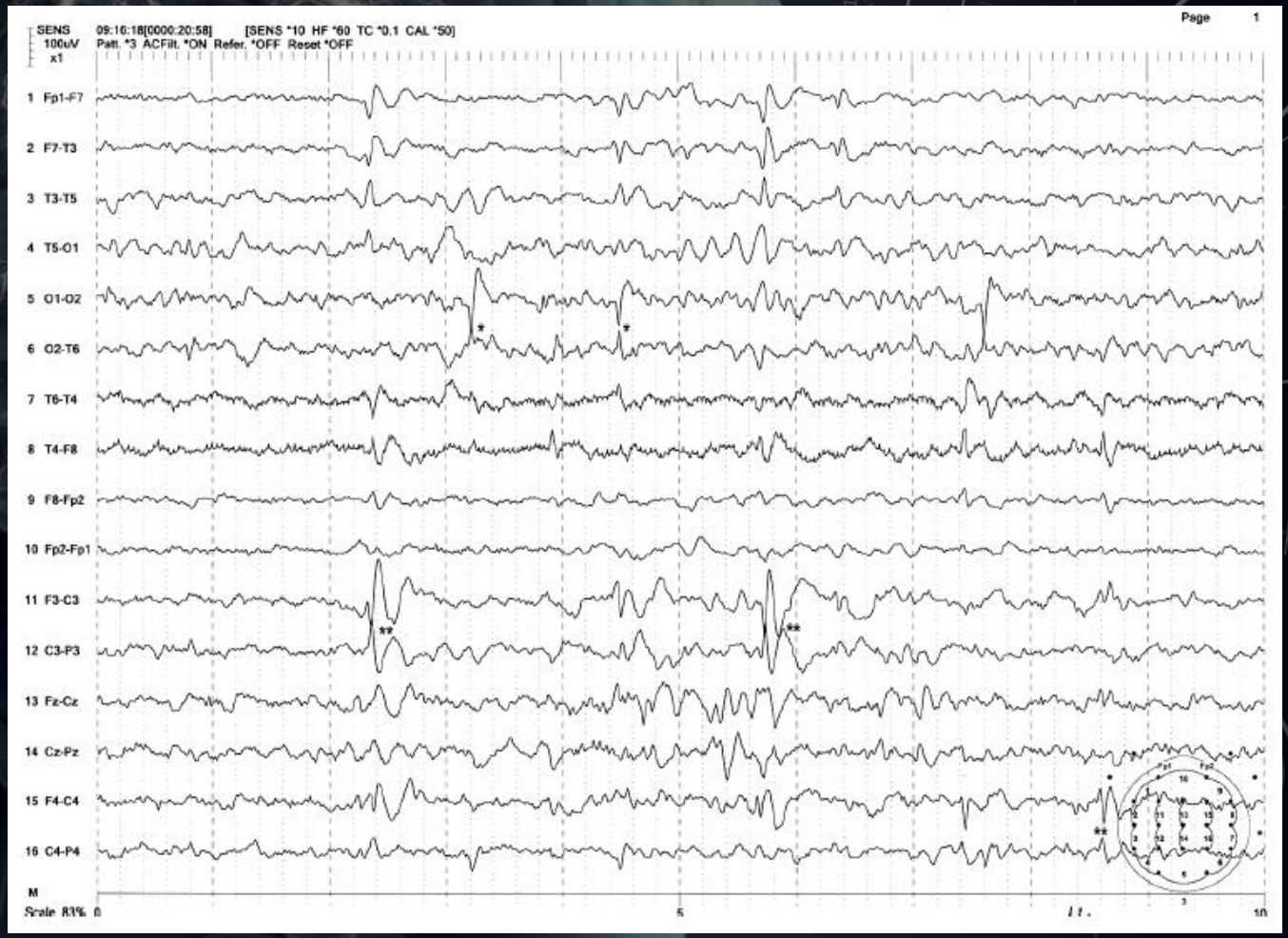
https://www.epilepsy.org.au/about-epilepsy/understanding-epilepsy/nocturnal-seizures-seizures-during-sleep/

BENIGN CHILDHOOD EPILEPSY WITH CENTROTEMPORAL SPIKES (BECTS)

- Aka Benign Rolandic epilepsy
- Focal, idiopathic
- Most children will outgrow (starts ~ 3-13 with a peak around 8–9 years and ends around age 14-18)
- May feature altered speech, salivation, syncope

BECTS

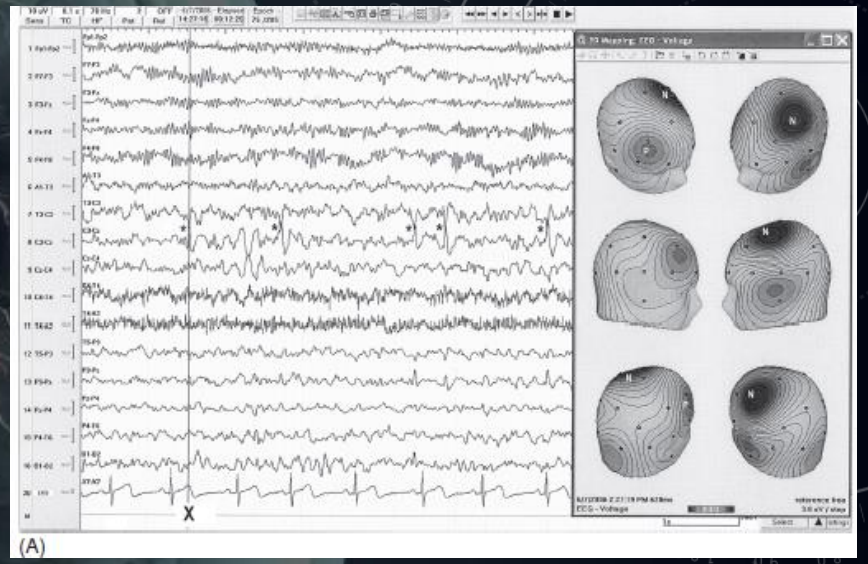
- Two coexisting types of benign paroxysm BECTS and childhood epilepsy with occipital paroxysm (benign occipital childhood epilepsy) in a 10-yo girl with a hx of generalized tonic-clonic seizures
- Note the two independent BECTS at C3/T3 and C4/T4

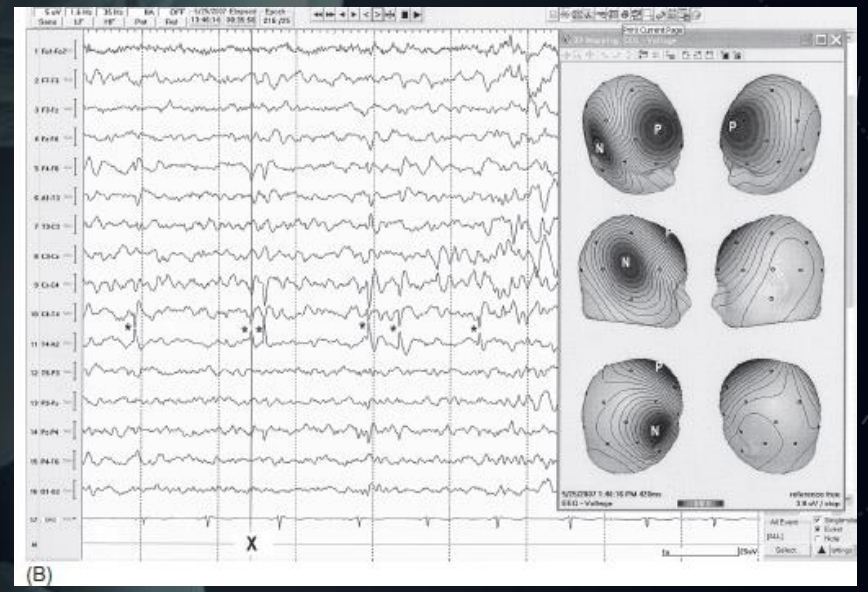


Yamada T, Meng E. *Practical Guide for Clinical Neurophysiologic Testing: EEG.* Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins, 2010

BECTS

- (A) 12 y.o. girl w. hx of nocturnal generalized tonic-clonic convulsions with postictal aphasia and right arm weakness (Todd's paralysis); EEG shows spikes maximum at C3
- (B) 10-year-old boy w/ hx of nocturnal generalized tonic-clonic convulsions; EEG shows spikes maximum at T4





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GENERALIZED TONIC-CLONIC

Tonic – muscle tone

- Tonic - limbs stiffen, body rigid
- Clonic - after period of stiffening, limbs and face begin to jerk rhythmically
- may have loss of bowel or bladder control
- afterwards: confusion, fatigue, headache

Video: Nguyen Tri Phuong Neurologic Department

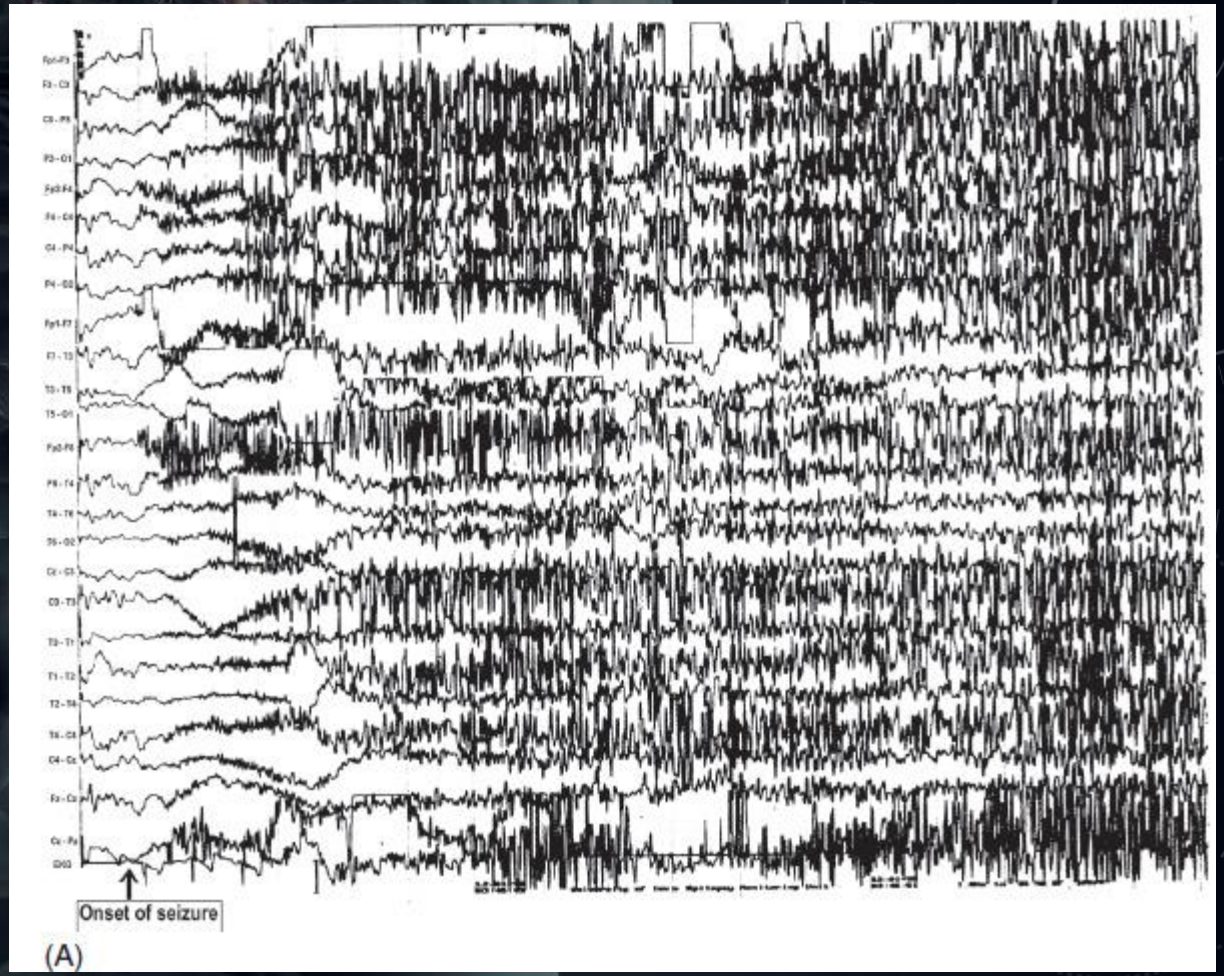
GENERALIZED TONIC-CLONIC

- Onset of the ictal event in this generalized seizure consists of low-voltage, rhythmic beta-range fast activity, with progressively increasing amplitude and decreasing frequency
- followed by generalized spike-wave bursts, which become progressively slower in frequency and less rhythmic toward the end of the seizure
- EEG suppressed during the immediate postictal period and is then followed by the appearance of postictal delta activity. Clinically, the initial fast activity corresponds with the tonic phase and the subsequent spike-wave bursts coincide with the clonic phase of the seizure
- During the ictal events, EEG activities are largely obscured by muscle and movement artifacts

Yamada T, Meng E. *Practical Guide for Clinical Neurophysiologic Testing: EEG.* Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins, 2010

GENERALIZED TONIC-CLONIC

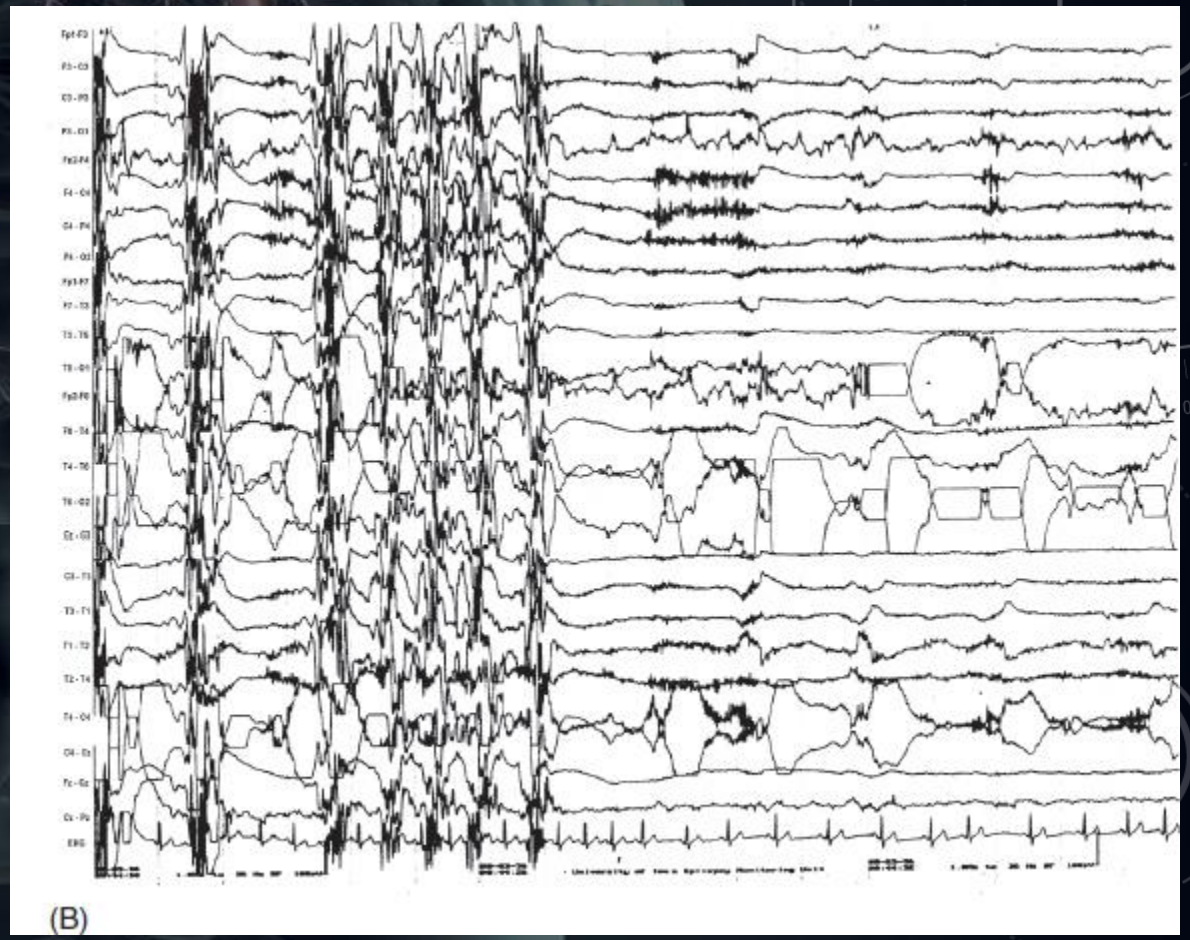
- (A) generalized ictal event in a 25-yo man with hx of seizures since childhood
- Note the sudden flattening of electroencephalography (EEG) activity at the onset, followed by beta activity peeking through the massive electromyogram (EMG) artifact during the tonic phase of seizure



Yamada T, Meng E. *Practical Guide for Clinical Neurophysiologic Testing: EEG.* Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins, 2010

GENERALIZED TONIC-CLONIC

- (B) Toward the end of the seizure, ictal discharges changed to periodic spike-wave discharges, which were contaminated by muscle artifact (clonic phase)
- Afterward, there was postictal suppression of EEG activity



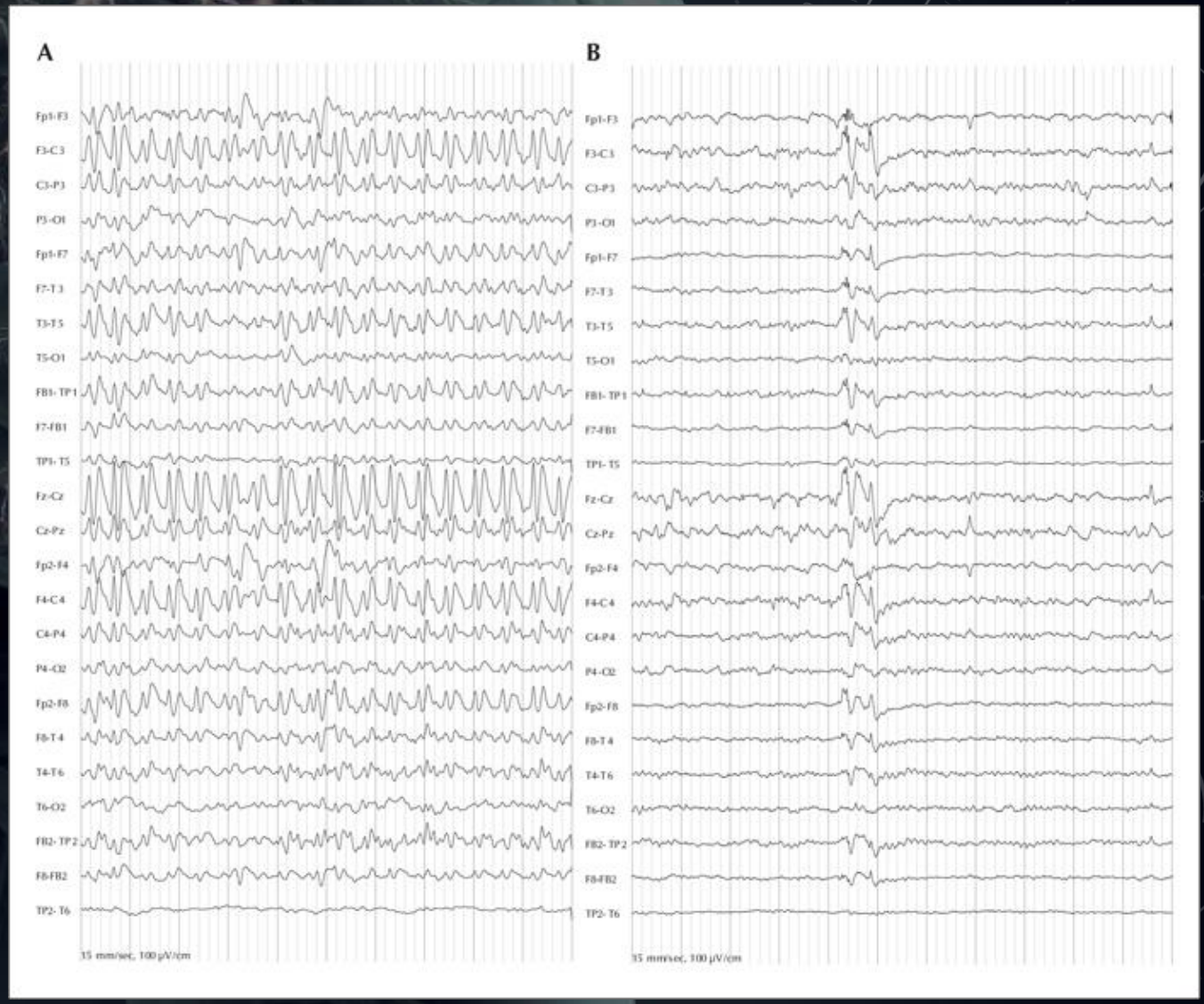
Yamada T, Meng E. *Practical Guide for Clinical Neurophysiologic Testing: EEG.* Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins, 2010

NOCTURNAL FRONTAL LOBE EPILEPSY

- sudden awakening with violent movement, dystonic or tonic posturing, and hyperactive behavior
- resembles night terror or RBD
- EEG may be normal or may show frontal slowing or spikes
- cluster of short fits, rapid start on/off
- sudden battering movements during sleep, head jerks to one side, upper limbs rising into brief, frozen state
- Behavioral automatisms eg rocking, bicycle pedaling movements and repetitive hand movements

NOCTURNAL FRONTAL LOBE EPILEPSY

- (A) epileptiform discharges Wake
- (B) epileptiform discharges in Sleep over midline and frontal region



Successful epilepsy surgery in frontal lobe epilepsy with startle seizures: a SEEG study. Epileptic Disorders. Volume 17, issue 4, December 2015

CASE STUDY 15 YO MALE W GENERALIZED EPILEPSY

- Intractable seizures, NDD, autism, nephrocalcinosis
- Presented in infancy with West Syndrome
- Enalapril, Topamax (topiramate), Zarontin (ethosuximide), Clobazam, vit B6
- Referred for snoring, gasping, pauses in breathing overnight, daytime sleepiness/fatigue, unable to stay awake during the day recently, more frequent naps
- initiated on APAP in community

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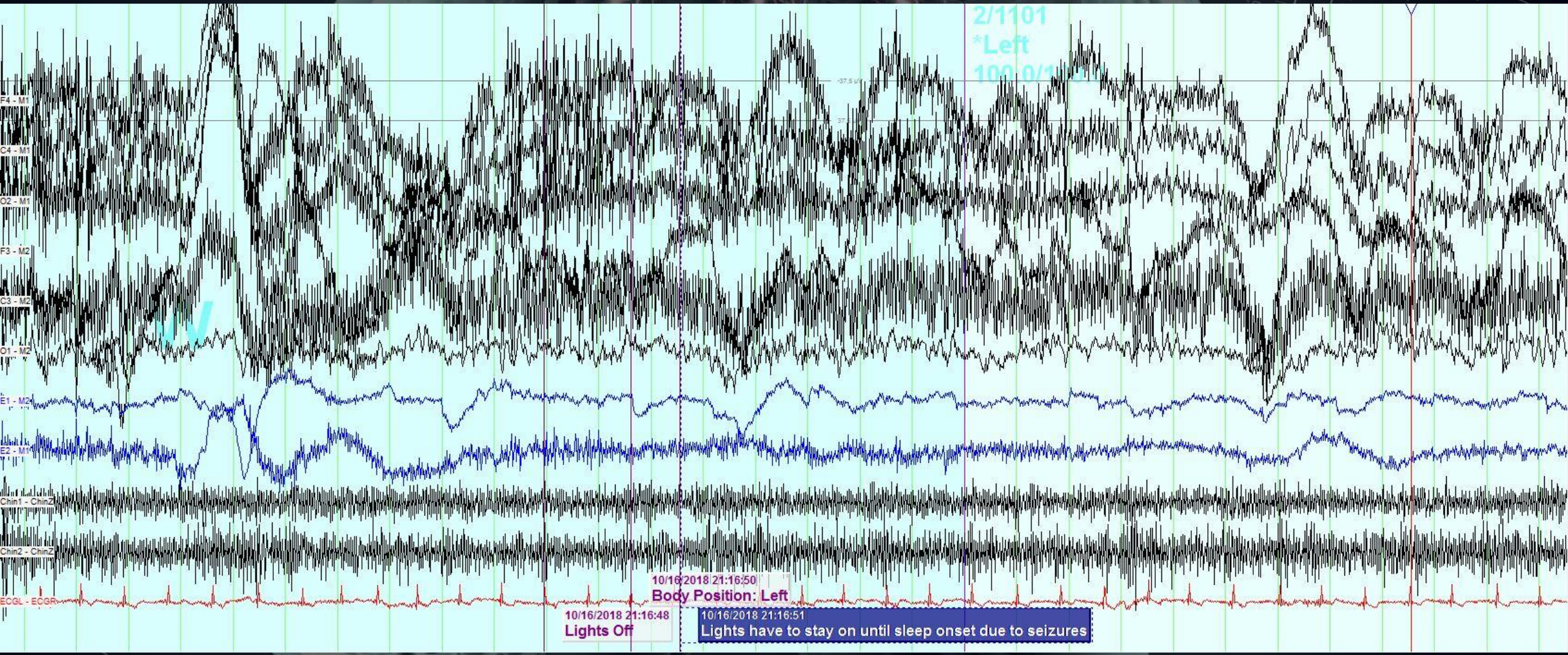

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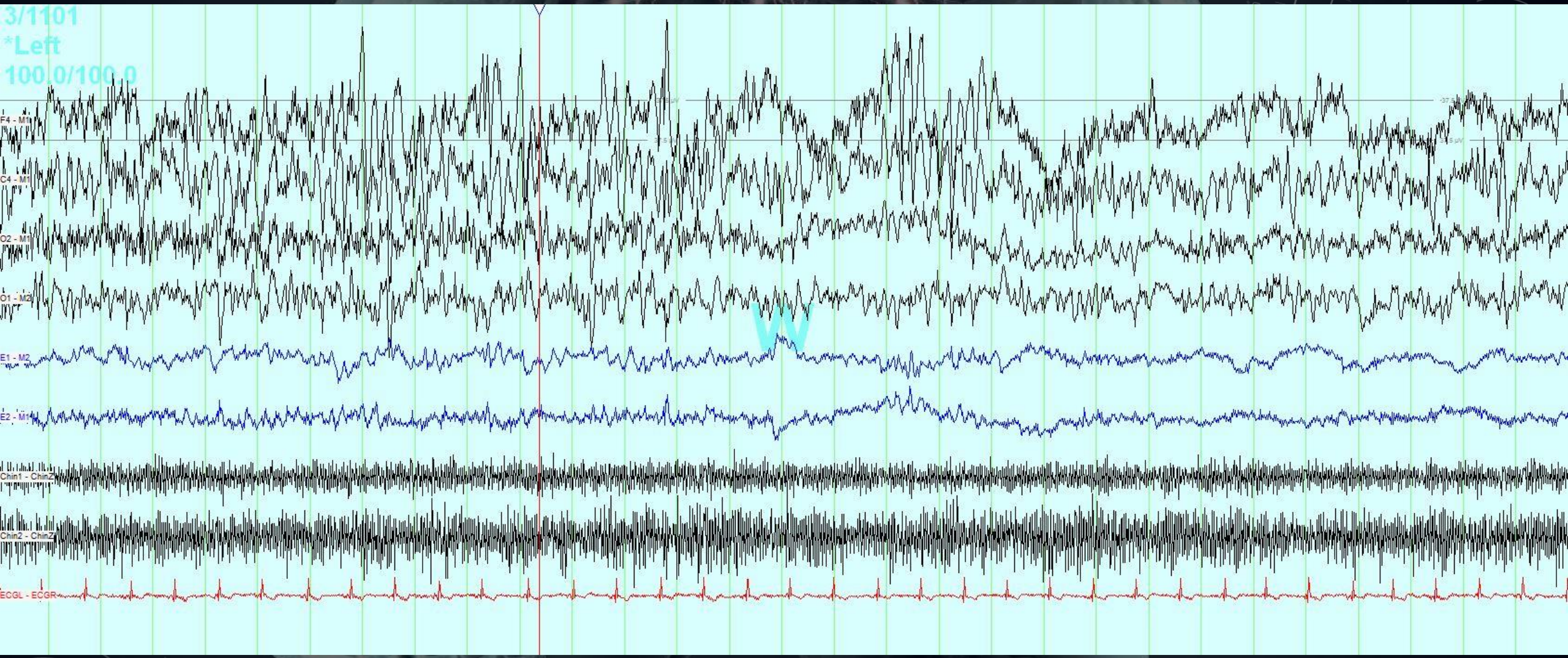

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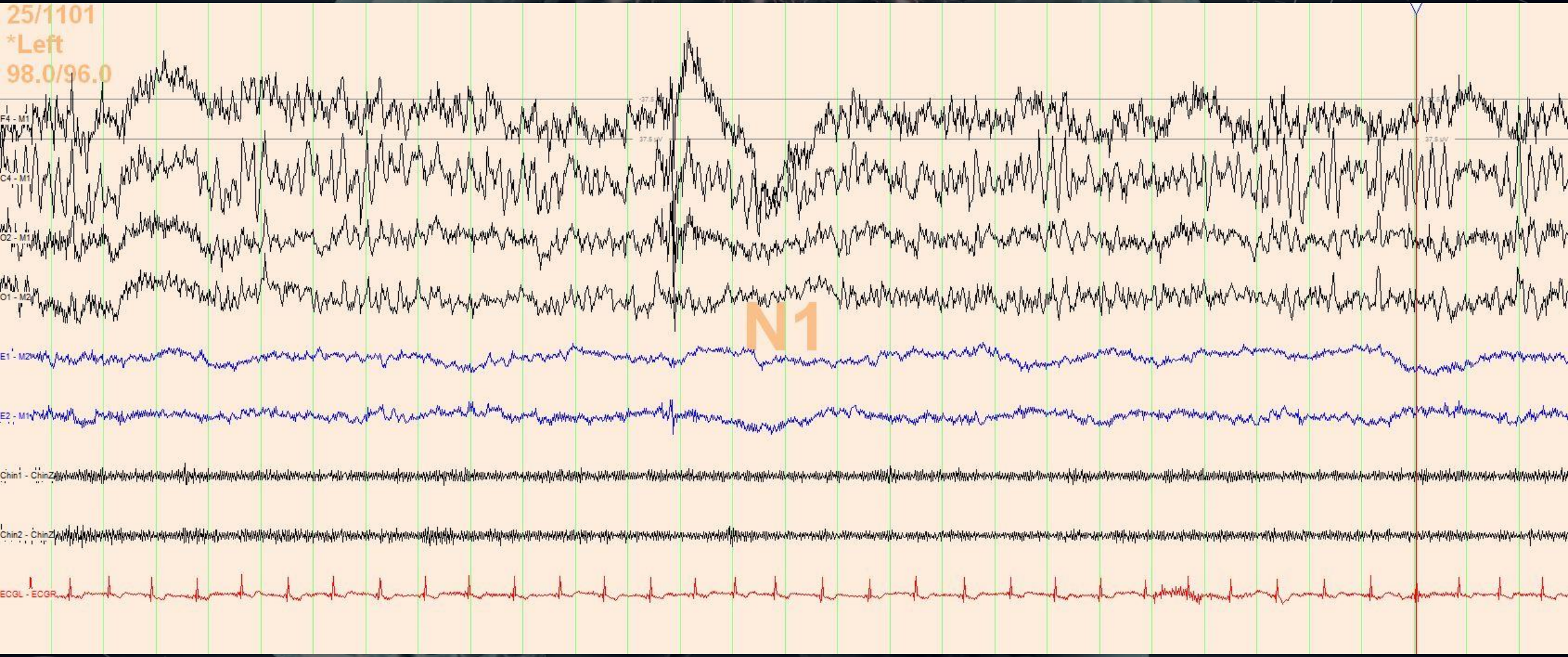

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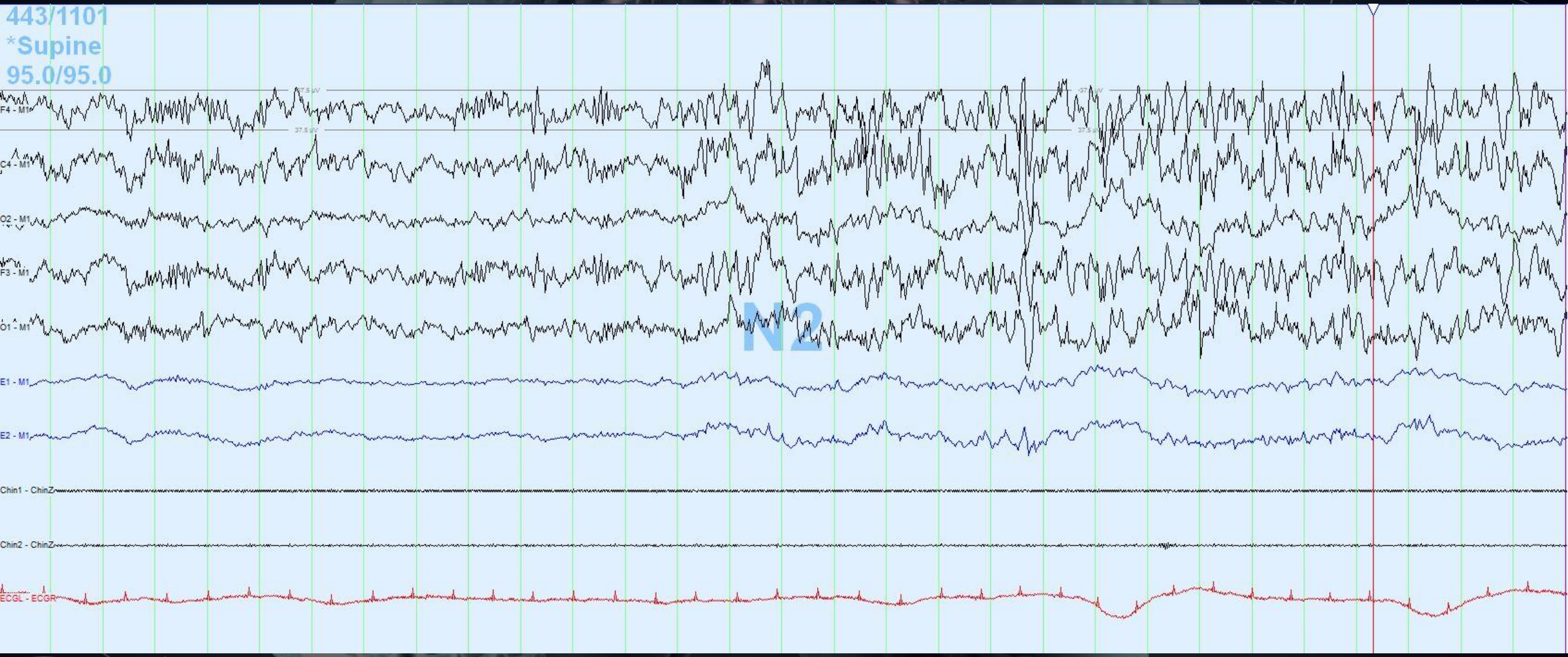

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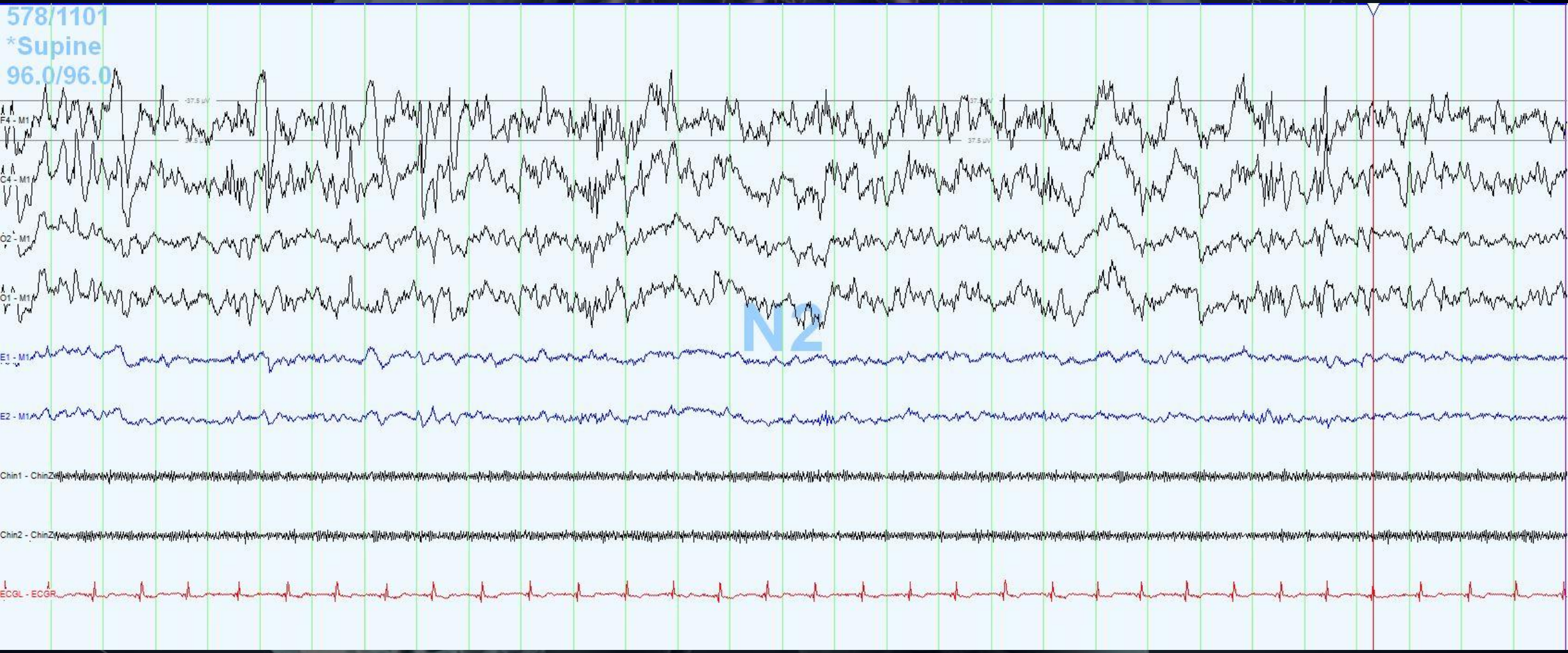

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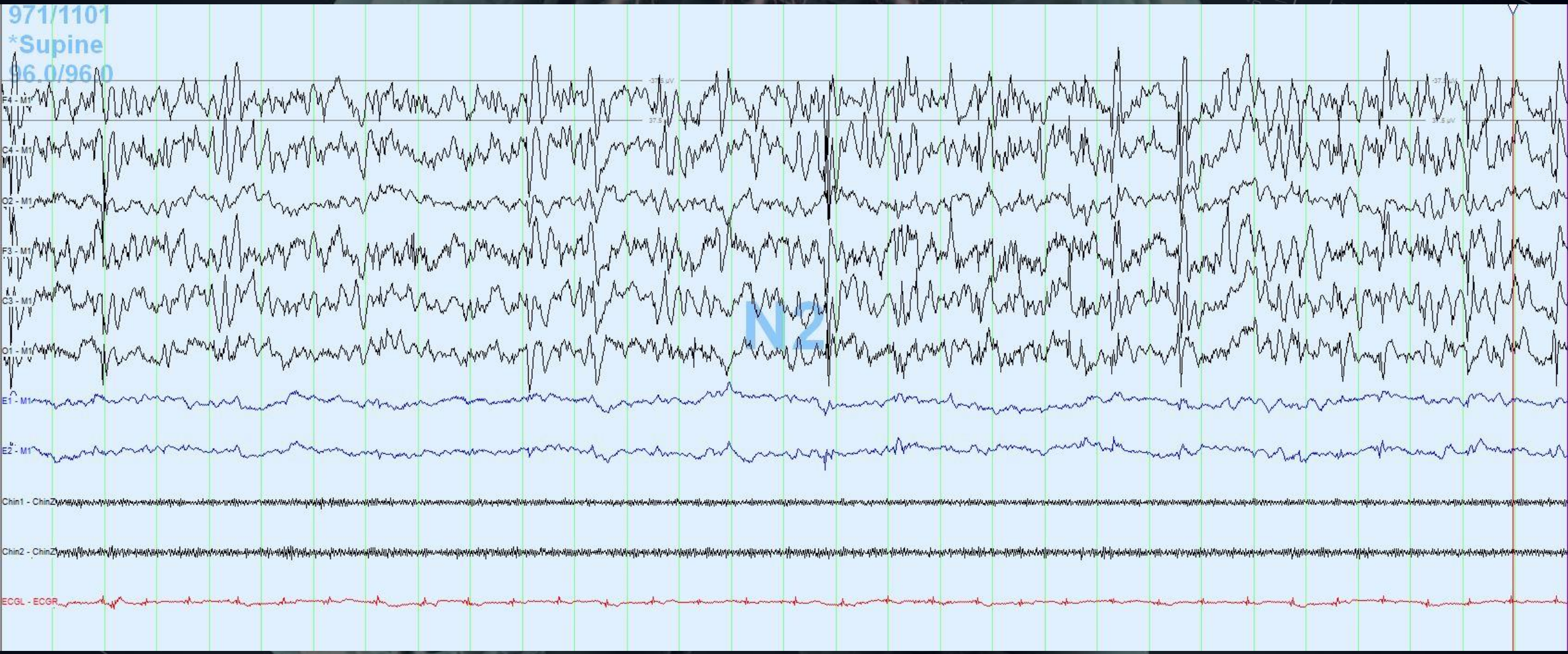

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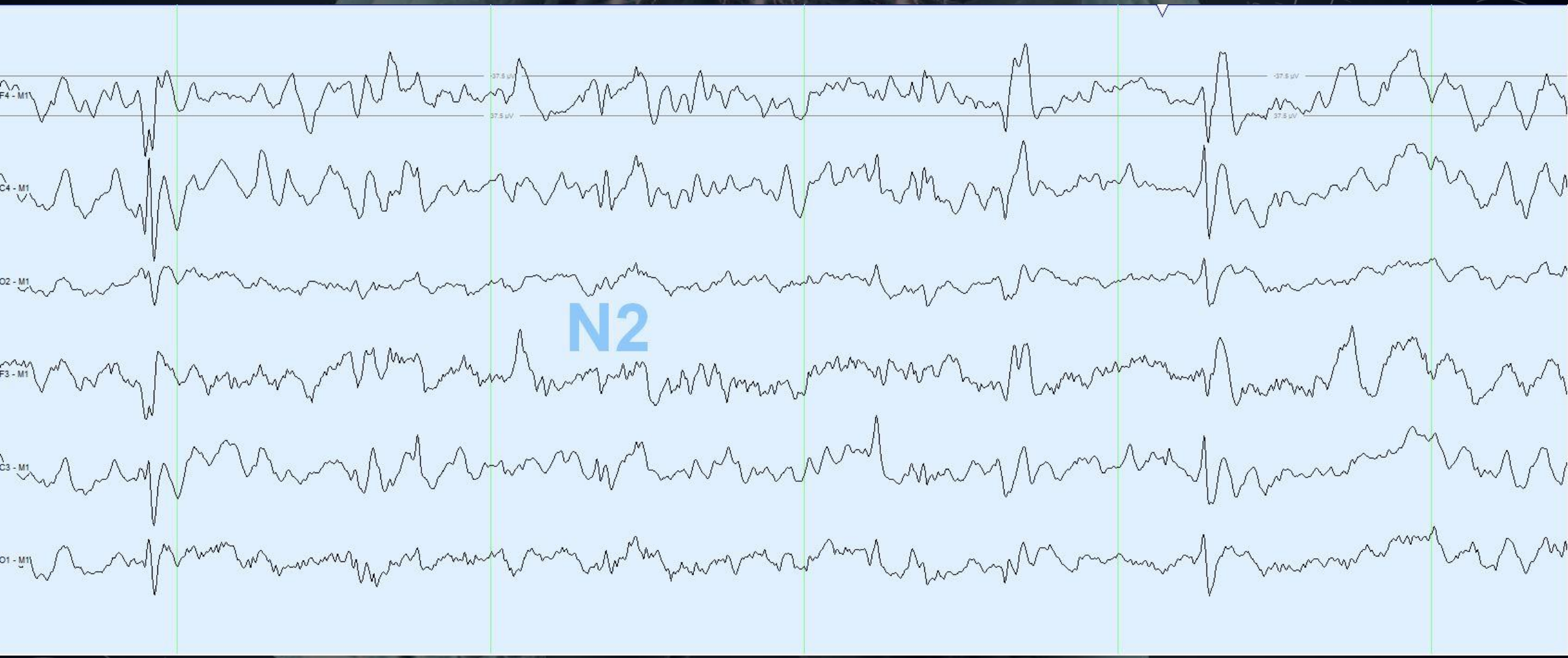

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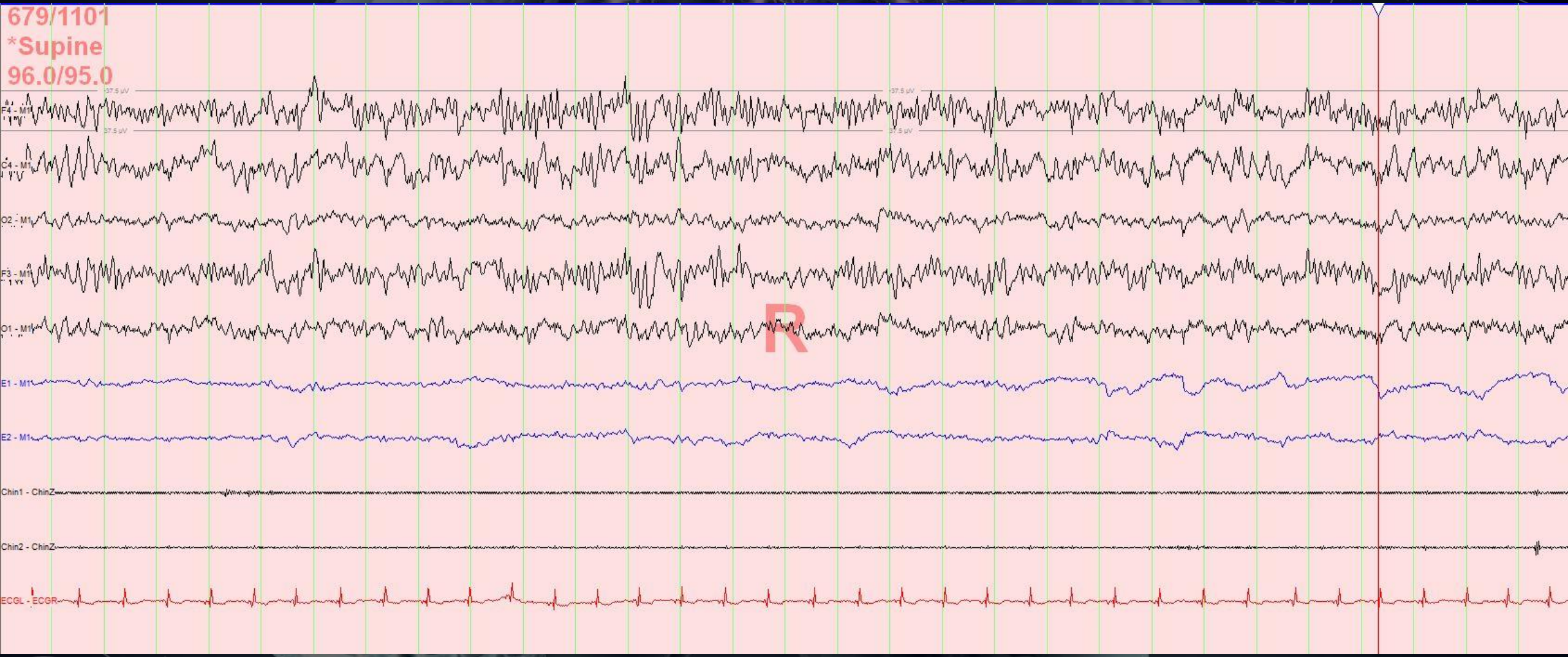

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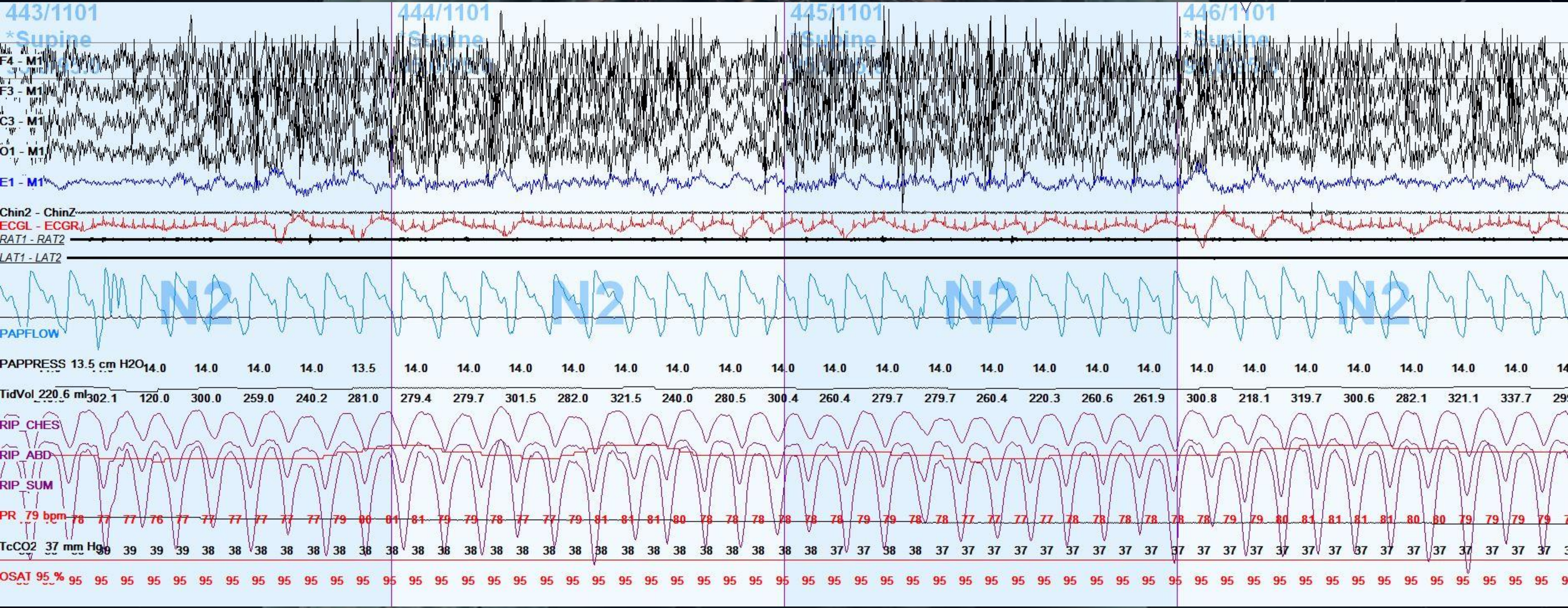

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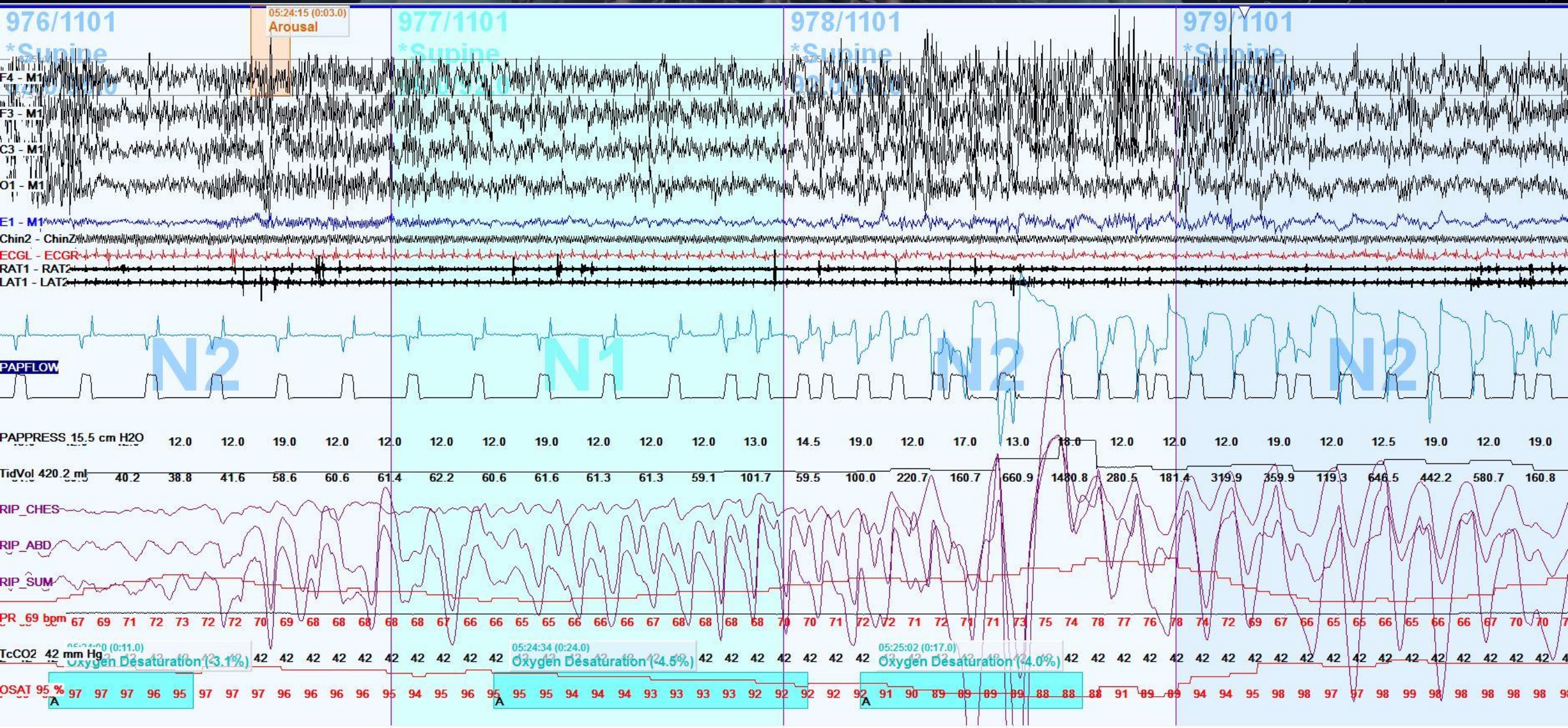
Poor ventilation BiLevel 19/12cmH2O R=12



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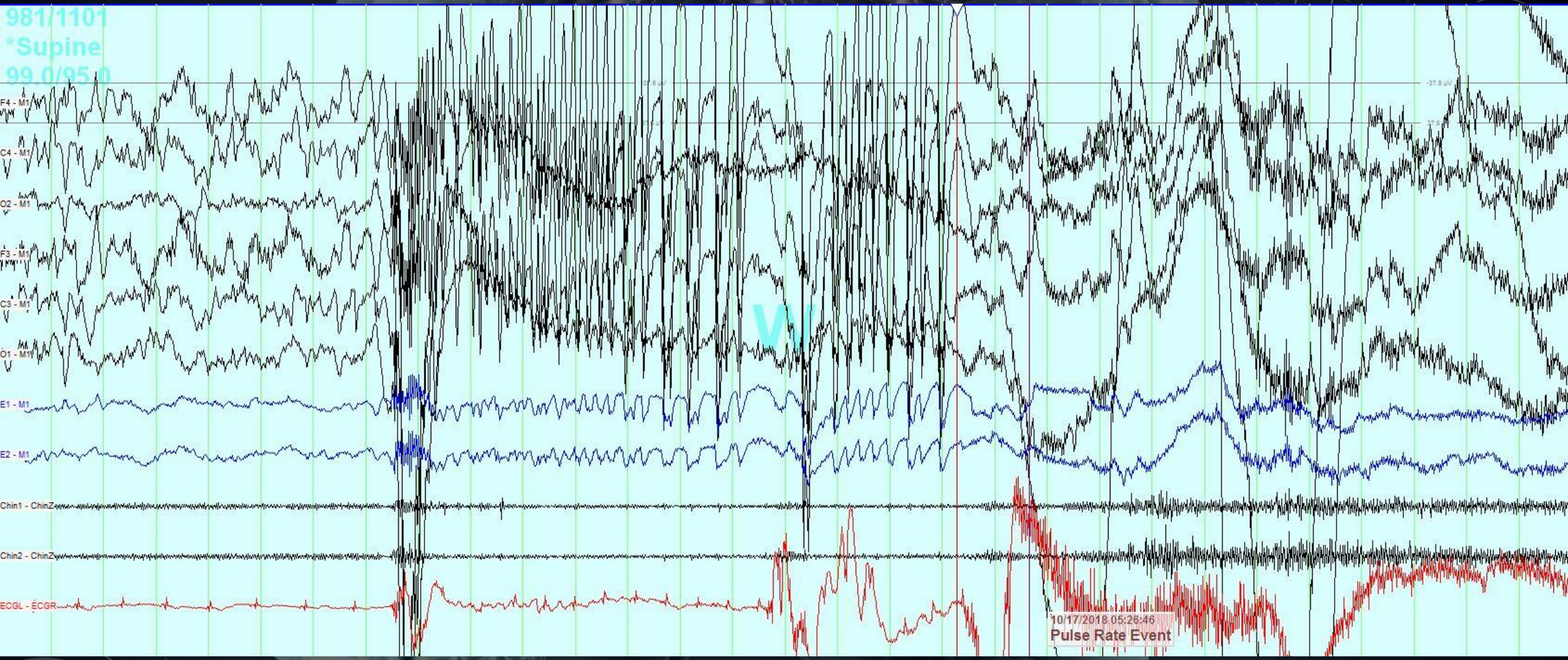

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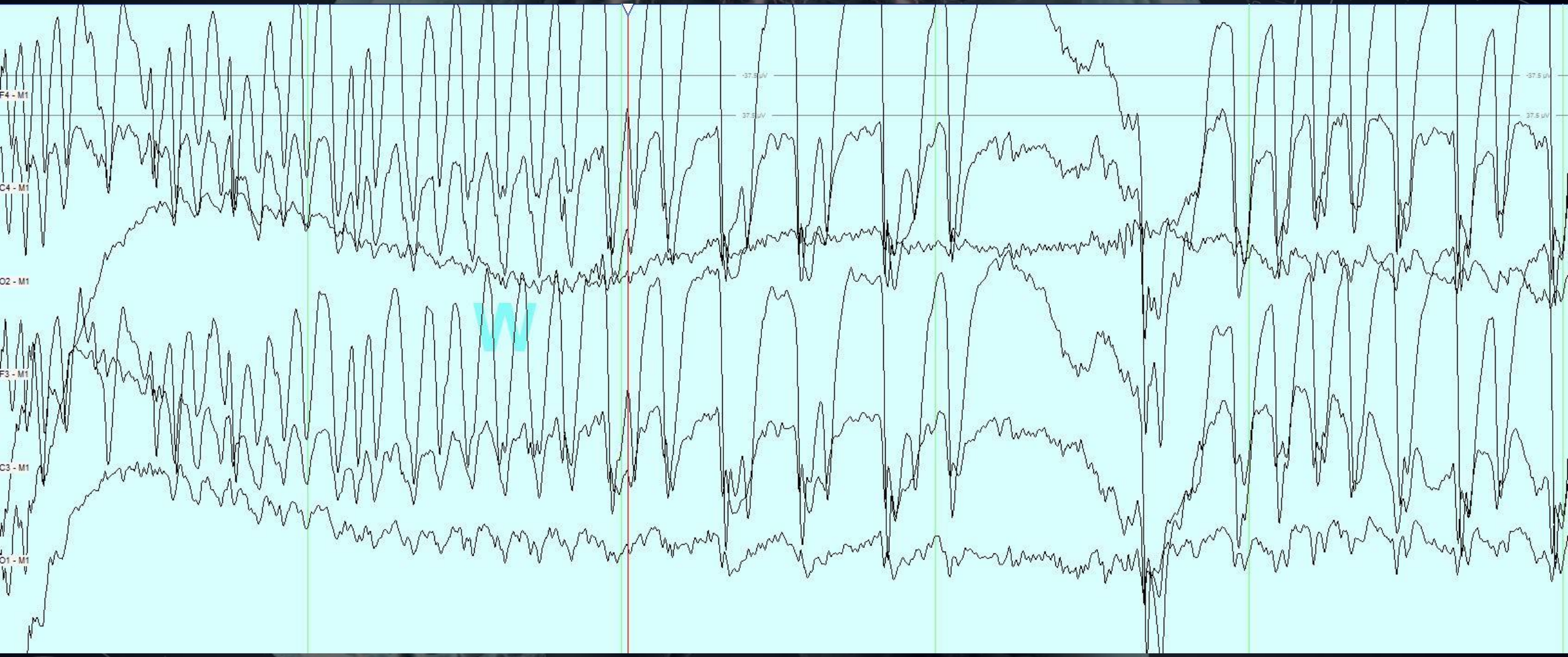

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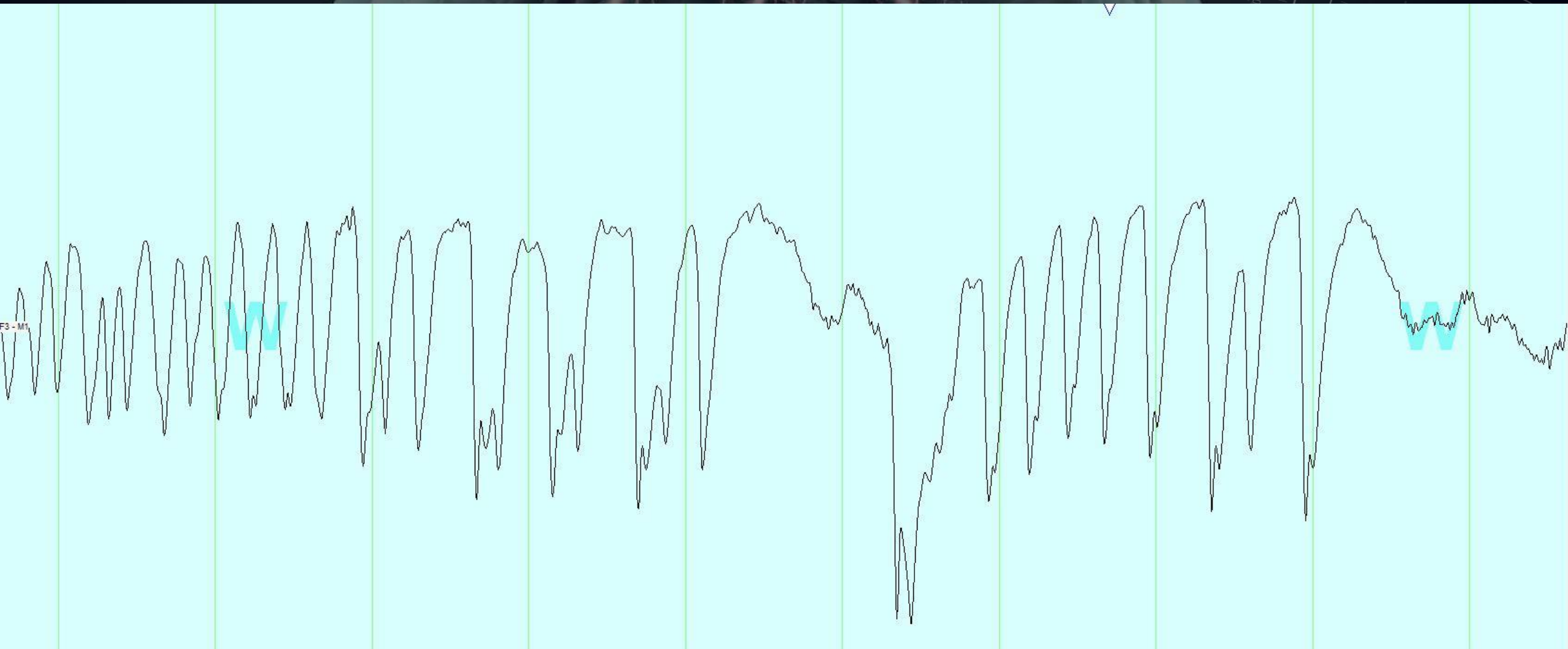
Spike-wave complexes 2-4Hz



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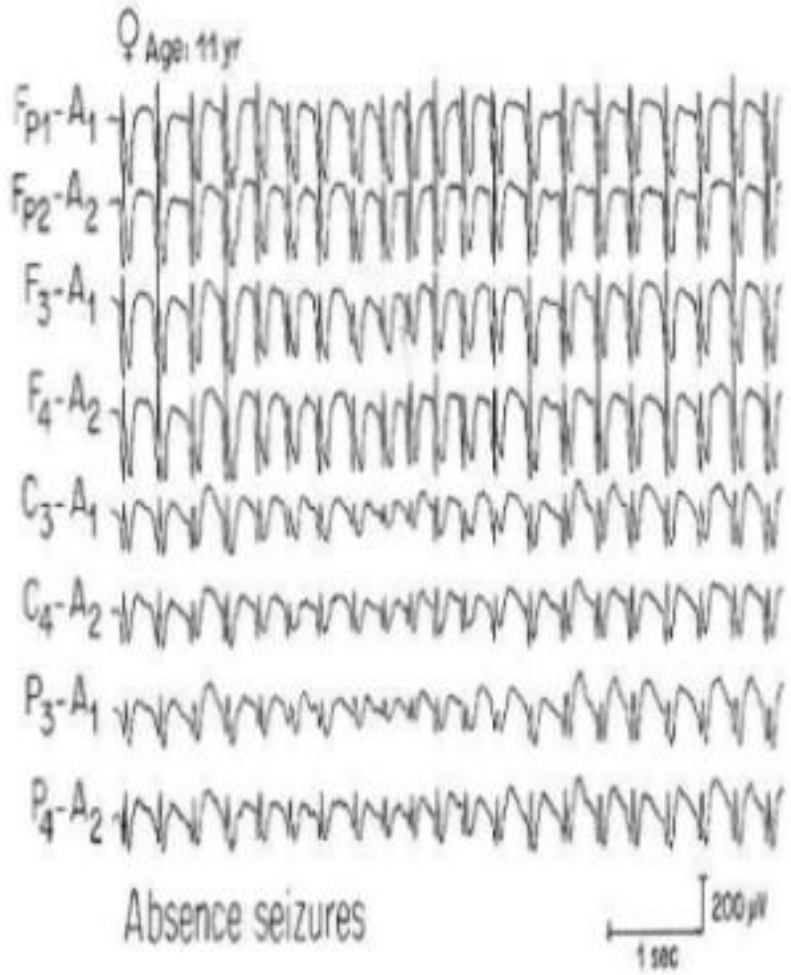
So absence in sleep??
Generalized motor seizure with tonic component



- Characteristics are 3 HZ spike wave complex
- Appears and goes of abruptly on normal background activity
- Maximum at frontal and midline region
- Starts at 4 HZ then slows down to 3.5 HZ then up to 2.5 Z
- Hyperventilation precipitate such attacks
- Paroxysm of more than 5 sec leads to clinical seizure

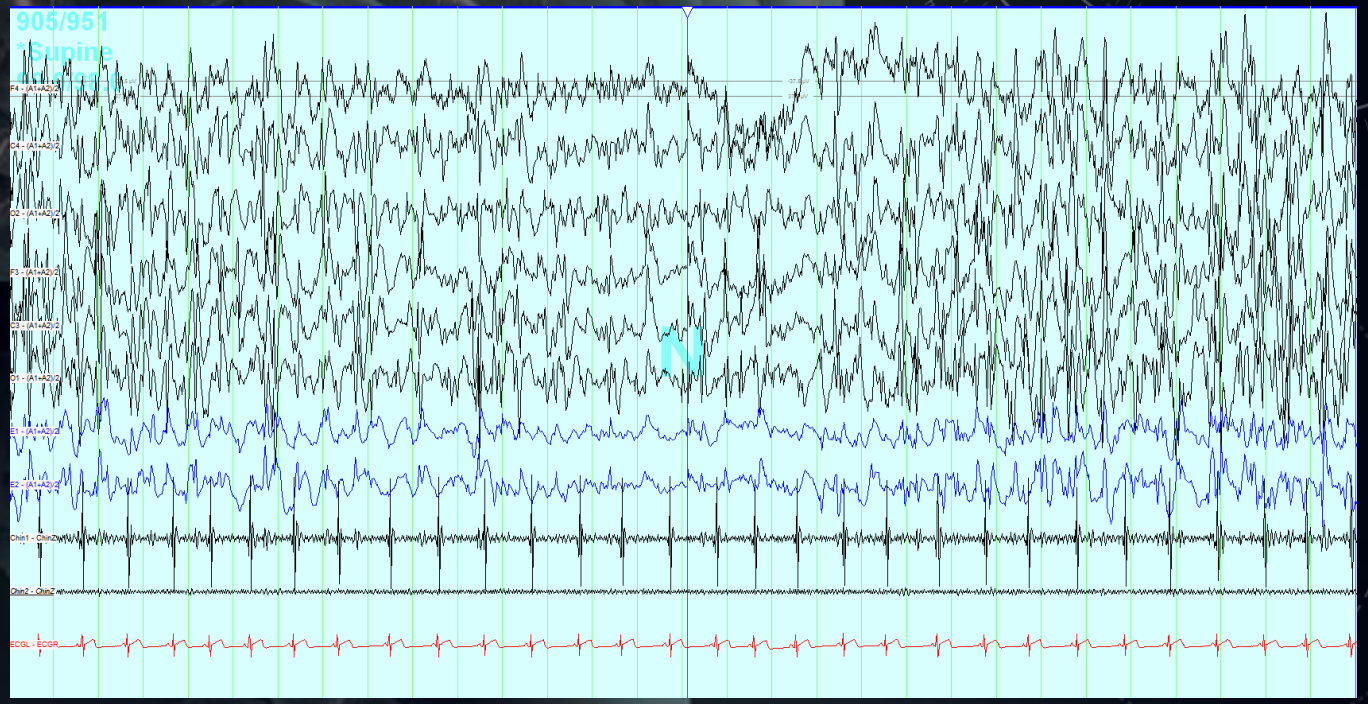
BENIGN VARIANTS

- “of uncertain clinical significance”
- E.g. wicket waves, rhythmic mid-temporal theta of drowsiness (RMTD or RTTD), benign small sharp spikes (BSSS, sometimes denoted BSST for benign small sleep transients), 14 and 6 positive spikes, 6-Hz “phantom” spike and wave, subclinical rhythmic EEG discharge of adults (SREDA), and the midline theta rhythm of Ciganek
- Are they reproducible? Play with the software, Filters, Montages, Use the referential montage, Get a repeat EEG, Get the context
- Many people have IEDs, some will develop epilepsy, some have diagnosed or undiagnosed neurological conditions but no clinical seizures

Electroencephalography (EEG): An Introductory Text and Atlas of Normal and Abnormal Findings in Adults, Children, and Infants. Britton JW, Frey LC, Hopp JLet al., authors; St. Louis EK, Frey LC, editors. Chicago: American Epilepsy Society; 2016.

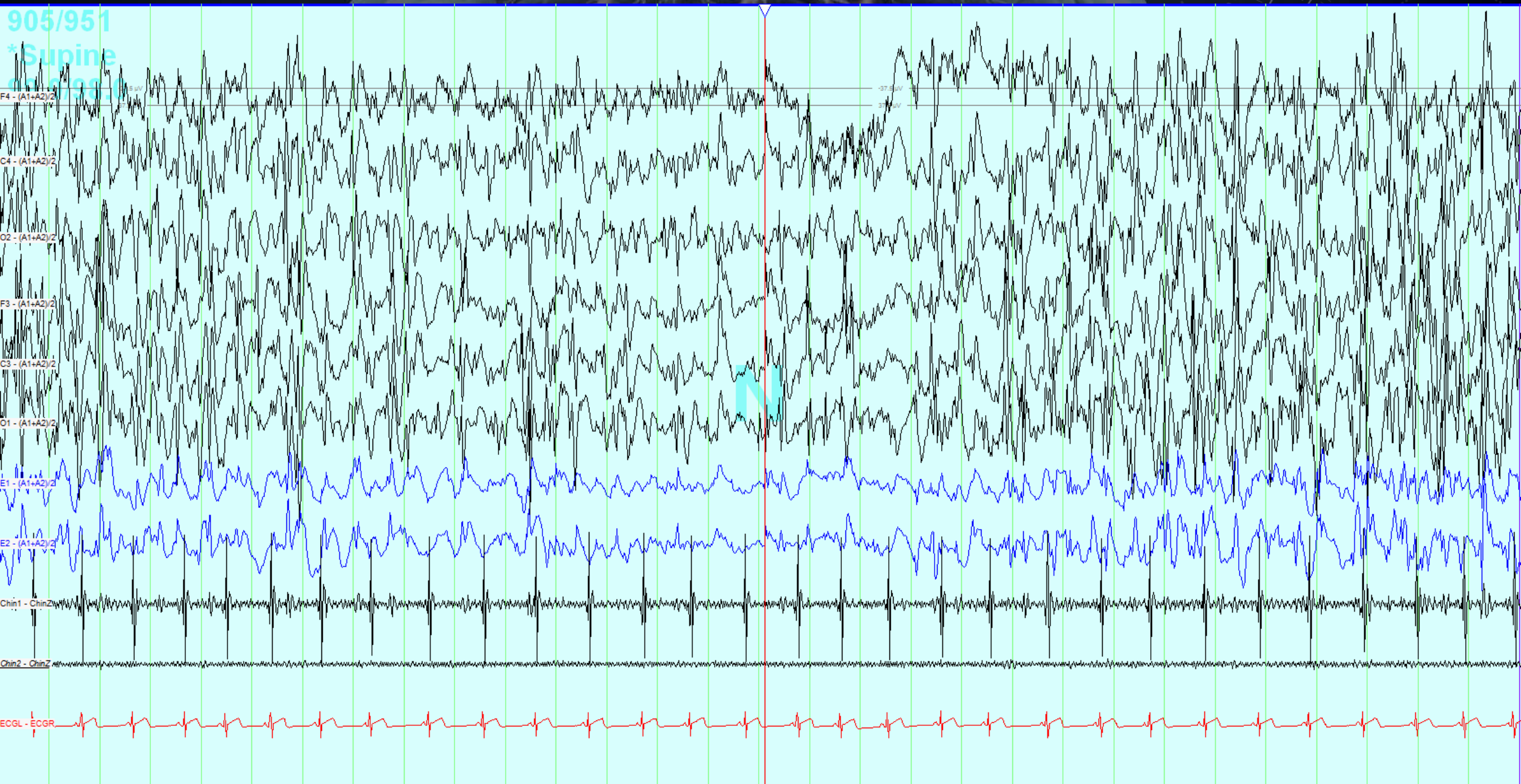
HOW DO YOU SCORE IT?

- Occasionally whole record will be abnormal EEG, lacking recognizable sleep features



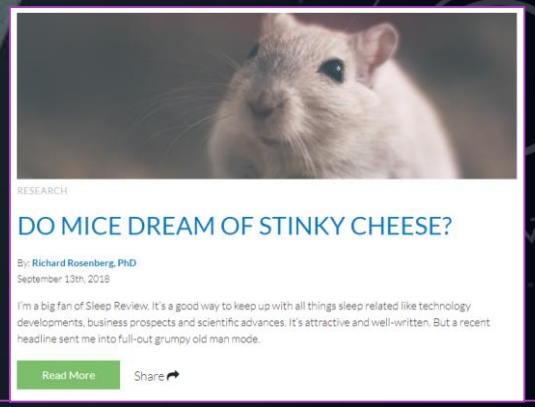
8 y.o. female with Mitochondrial Myopathy, seizure disorder

LFF 0.3Hz, HFF 35Hz, notch 60Hz, sens 15uV/mm, 10mm/sec (30s/page)



HOW DO YOU SCORE IT?

- Richard Rosenberg, PhD 'I wouldn't even try'
- Use the pediatric scoring set (if available), and score as NREM vs REM vs W, or even just NREM vs W



https://www.aastweb.org/blog/author/richard-rosenberg-phd

WHAT HAPPENS WHEN A PATIENT HAS A SEIZURE IN THE SLEEP LAB?

HAVE A PLAN (AND KNOW THE PLAN)

Before the study:

- P&P
- Familiarize yourself with the names of anti-epileptic medications
- Talk to the patient, ask about seizures - when diagnosed? controlled? when was last seizure? how does it manifest?

KNOW THE COMMON TRIGGERS

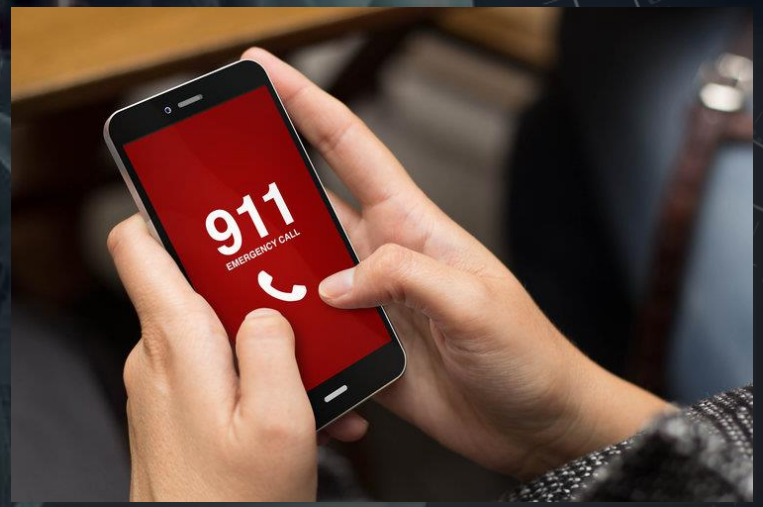
- Sleep deprivation
- Alcohol intake
- Stress
- OSA
- photosensitive patients, seizures can be precipitated by television

https://www.epilepsy.com/learn/professionals/refractory-seizures/actions-take/identify-and-reduce-triggers
Elger CE, Schmidt D. Modern management of epilepsy. Epilepsy Behav 2008;12:501-39.

EPILEPSY ACTION PLAN - IS IT AN EMERGENCY?

A seizure is generally considered an emergency when:

- Convulsive (tonic-clonic) seizure lasts longer than 5 minutes
- Or repeated seizures without regaining consciousness
- = Status Epilepticus
- types of status epilepticus: convulsive and non-convulsive
- Convulsive status epilepticus requires emergency treatment by trained medical personnel in a hospital setting as it may be life-threatening



https://www.epilepsy.com/sites/core/files/atoms/files/seizure-action-plan-pdf_0.pdf

EPILEPSY ACTION PLAN

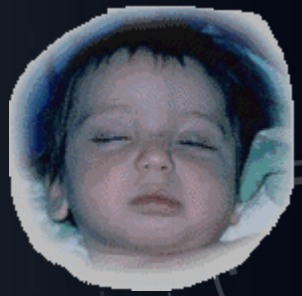
- Communication - other techs
- Be reassuring, comforting and stay calm
- Track and record time, and note as much detail as possible (time, description of movements)
- Basic 1st aid:
- Environment - recovery position, remove objects, protect head (pillows, rolled up sheets)
- **Do not** restrain
- **Do not** put anything in mouth
- Keep airway open and watch breathing
- Stay with them until fully conscious
- Call your MD

https://www.epilepsy.com/sites/core/files/atoms/files/seizure-action-plan-pdf_0.pdf

DIFFERENTIAL DIAGNOSIS

- 3 m.o. infant, in PICU, grandma reports frequent seizures
- Upon pre-study interview, reported to sleep tech unusual eye movements when asleep
- EEG showed normal sleep stages, no apparent spikes/spike waves, no clinical seizures
- LAMF, low chin EMG, and eye movements

"His eyes go all 'funny'. I've had 3 children and many grandchildren and none of them ever did this"

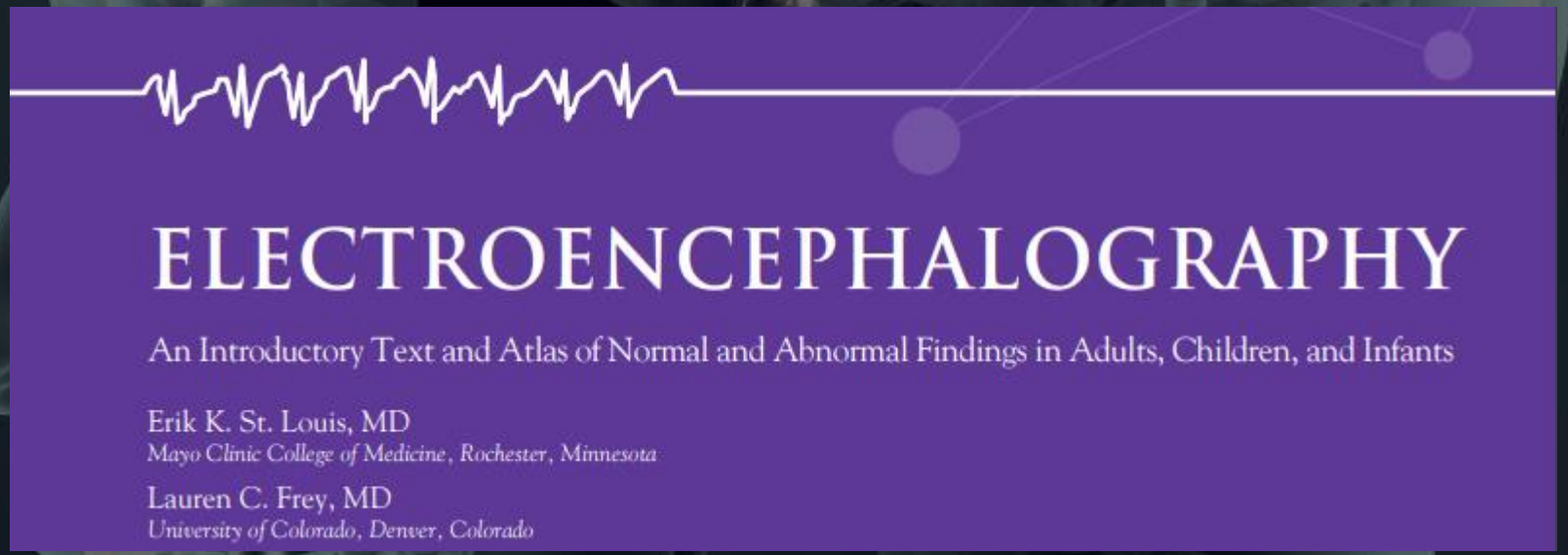


"Oh look, there he goes, he's doing it!"

St R with REMs!

QUESTIONS?

colin.massicotte@sickkids.ca



Canadian Sleep Society
Société Canadienne du Sommeil
Journées de formation SCS 2018
2018 CSS Education Meeting