

**Diagnosis of Epilepsy
Video EEG & Imaging :**
A multidisciplinary approach to
intractable epilepsy

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**ELECTROENCEPHALOG
RAPHY**

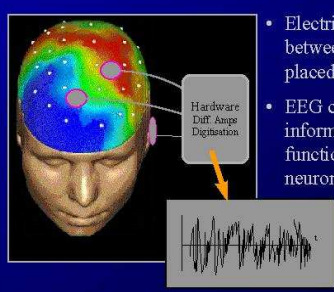
EEG

การส่งตรวจคลื่นไฟฟ้าสมอง

EEG

- การตรวจคลื่นไฟฟ้าสมอง
 - เป็นการบันทึกสัญญาณไฟฟ้า ซึ่งเกิดจากผลรวมของกระแสไฟฟ้าของกลุ่มเซลล์ในสมอง ผลการตรวจจะปรากฏเป็นรูปกราฟบนแถบกระดาษ หรือในจอภาพ (มอนิเตอร์)

**Electroencephalogram
Measurement**



- Electrical potentials between electrodes placed on scalp
- EEG contains information about the functioning of the neurons

Video-EEG

- **Time locked video/surface or invasive EEG**
- **Use seizure semiology “Lateralizing Sign” + Electrical data for localization**



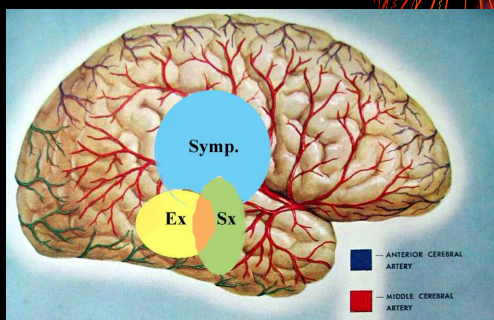
Lateralizing Sign

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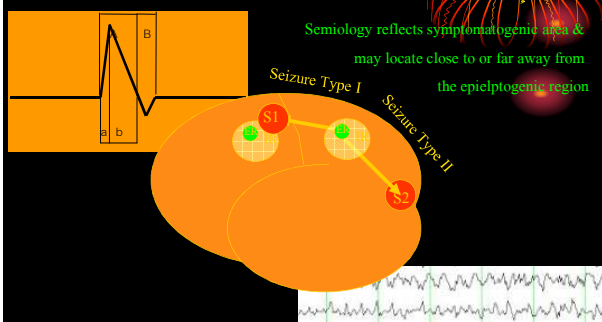
Lateralizing Signs

- Physical signs occurred during partial seizures or post ictal periods with proven relationship with the side of the epileptogenic regions.
 - Ipsilateral / contralateral
 - dominant / nondominant hemisphere

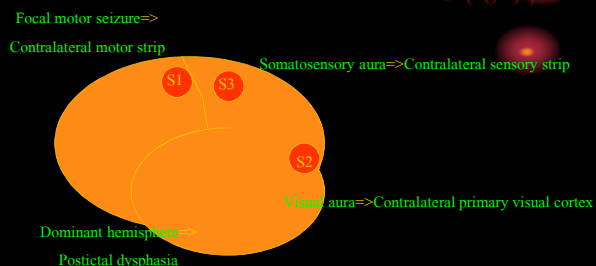
Epileptogenesis



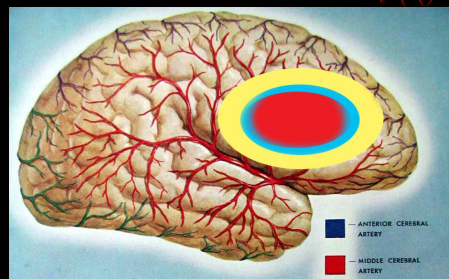
Irritative, Epileptogenic & Symptomatogenic Zones



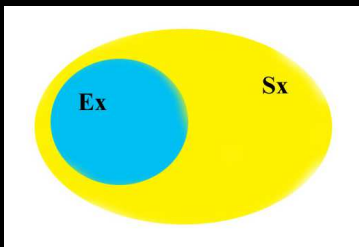
Lateralizing Signs : Eloquent Areas



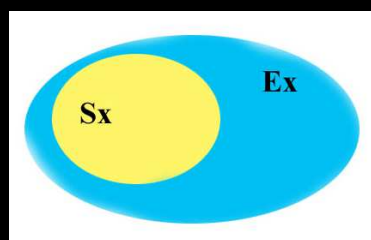
Epileptogenic lesion



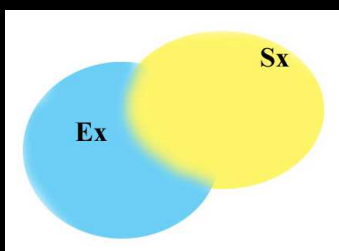
Epileptogenesis



Epileptogenesis



Epileptogenesis



Lateralizing Signs : List

1. Version of head & eye
 - During seizures
 - At the end of GTC of versive seizures:
2. Unilateral dystonic posturing
3. Unilateral automatism
4. Ictal speech/Vocalization
5. Ictus vomiting
6. Automatism with preserved responsiveness (APR)

Lateralizing Signs : Versive

- Contraversive during seizure : Unquestionably forced & involuntary tonic or clonic head & eye movement, resulting in sustained unnatural positioning.
- Wyllie E. (1986) : contralateral versive movement occurred during seizures in 61(74) seizures in 27(37) patients -Heads & eyes moved together in 40/61 Sz. 7/61 eye only can not analyze eye movement in the rest

Neurology 1986 May;36(5):696-11: The lateralizing significance of versive head and eye movements during epileptic seizures. Wyllie E, Luders H, Morris HH, Lesser RP, Dinner DS

Lateralizing Signs : Versive

Location of seizure onset	Total	Versive head and eye movements		Nonversive head and eye movements	
		Ipsi-lateral	Contra-lateral	Ipsi-lateral	Contra-lateral
Frontal	39 (12)	0 (0)	37 (10)	0 (0)	2 (2)
Temporal	31 (22)	0 (0)	20 (14)	7 (4)	4 (4)
Parietal	2 (2)	0 (0)	2 (2)	0 (0)	0 (0)
Occipital	2 (1)	0 (0)	2 (1)	0 (0)	0 (0)
Total	74 (37)	0 (0)	61 (27)	7 (4)	6 (6)

Numbers refer to seizures (patients). Numbers in parentheses refer to hemisphere of seizure onset

Lateralizing Signs : Versive

Location of seizure onset	Total	Quiet staring	Staring and automatisms	None (versive at onset)
Frontal	37 (10)	5 (5)	0 (0)	32 (10)
Temporal	20 (14)	2 (2)	18 (14)	0 (0)
Parietal	2 (2)	1 (1)	0 (0)	1 (1)
Occipital	2 (1)	0 (0)	0 (0)	2 (1)
Total	61 (27)	8 (8)	18 (14)	35 (12)

Numbers in parentheses (patients)

local signs preceding contraversive head & eye movements.

Lateralizing Signs : Versive

- Once contraversive begins
=> focal motor activities of arm & face are common,
=> can assume fencing position, (M2e, secondary motor area)
- Distinction of versive & non versive is critical to the accuracy of this sign

Lateralizing Signs : Versive

- The first versive movement of each seizure whether it occurred **initially** which is more common in **extra temporal** or **after a period of staring & automatism** as in the **temporal lobe epilepsy**
- Nonversive lateral head and eye movements occurred ipsilaterally and contralaterally with equal frequency and were nonlocalizing, but versive movement was a reliable lateralizing sign.
- Version will be more specific if
 - Occurred just prior to secondary generalization
 - Accompanied by neck extension or mouth deviation.

Lateralizing Signs : Versive

- Studied the eye movements (EM) elicited by electrical stimulation of the frontal lobe in 19 awake patients
- All had contralateral conjugated EM.
 - saccadic in 16 patients (84%).
 - 11 patients (58%). Had head version, always following the eye deviation,
- eye field somatotopic distribution
 - All patients had motor cortex contiguous to the eye fields.
 - In 17 patients (90%) the eye fields were located in front or at the level of the motor representation.
 - No silent cortex between the motor strip and the eye fields.

Versive eye movements elicited by cortical stimulation of the human brain.; Neurology 1990 Feb;40(2):296-9 ; Godoy J, Luders H, Dinner DS, Morris HH, Wyllie E Section of Epilepsy and Clinical Neurophysiology, Cleveland Clinic Foundation, OH.

Late Ipsiversion after GTC

- 61 versive seizures in 27 epileptic patients
- 12 of the 27 **secondarily generalized versive seizures** also had ipsilateral head and eye version at the end of the generalized convulsion.
 - During initial contraversion, ictal activation was predominant in the hemisphere of seizure onset;
 - during late ipsiversion, in the hemisphere involved by secondary generalization.
- Late version, unlike initial version, is frequently ipsilateral and cannot be assumed to indicate seizure onset in the contralateral hemisphere.

Ipsilateral forced head and eye turning at the end of the generalized tonic-clonic phase of versive seizures.; Neurology 1986 Sep;36(9):1212-7; Wyllie E, Luders H, Morris HH, Lesser RP, Dinner DS, Goldstick L

Unilateral dystonic posturing/automatism

- Definition : Forced, Unnatural posturing of arm or leg on one side usually with rotatory movement.
- First noted in 1985 that in pts w/ Sz free after temporal lobectomy has this sign => localizing value.
- The study was done initially retrospectively by reviewing 91 Sz of 31 pt => 14 Sz from 8 pt have dystonic posturing.

Dystonic posturing in complex partial seizures of temporal lobe onset: a new lateralizing sign.; Neurology 1989 Feb;39(2 Pt 1):196-201 ; Kotagal P, Luders H, Morris HH, Dinner DS, Wyllie E, Godoy J, Rothner AD

Unilateral dystonic posturing/automatism

Lateralizing signs	Group I: 91 CPS from 31 patients seizure- free postsurgery		Group II: 27 additional CPS with dystonic posturing	
	Ipsi	Contra	Ipsi	Contra
Unilateral dystonic posturing	0	14 (8)	0	27 (10)
Unilateral automatisms in presence of dystonic posturing	13 (7)	0	26 (9)	0
Unilateral automatisms alone	7 (5)	6 (3)	0	0
Version of eyes and/or head	0	14 (8)†	0	5 (4)‡§

Unilateral dystonic posturing/automatism

- Always involve the arm, associated with tremor / choreoathetosis
- Occurred 17 seconds after clinical onset, 15 s after scalp EEG onset & 53 s after subdural EEG onset. Lasting 28 sec. (10-65).
 - 13/14 has unilateral hand automatism in opposite hand during dystonia. 10/13 started off w/ B/L hand automatism & was then interrupted.
 - Tonic alone => Contralateral ER in 7/19 and has ipsilateral ER in 3/10 Sz.
 - Unilateral automatism alone = 13/91 in 8 pt. with 1/2 ipsilateral, 1/2 contralateral ER.
- Always occurred before contralateral version of the head (6/91 Sz from 4/31 patients)
- Occurs even when the patients do not have secondary generalization.
- Not indicating a poor prognostic sign (used to be believed that this indicated a rapid fronto/parietal spread.)
- Distinction between tonic & dystonic posturing is essential (esp use rotatory & unnatural posturing as a key)

Ictal vocalization

- Lateralising value of non-speech vocalisations in seizures originating in the frontal lobe.
- frontal lobe seizures, seizure free > 1 year postoperatively.
- Twenty seven patients aged 1-42 years (mean 18)
- Age at epilepsy onset ranged from 1 month to 41 years (mean 7.1 years).
- All selected patients had a unilateral MRI detected lesion within the frontal lobe.
- Fifteen patients had right sided, 12 patients had left sided epileptogenic zones.
- Pure ictal vocalisations were distinguished from ictal sound productions due to motor or vegetative seizure activity (for example respiratory sounds).
- Pure ictal vocalisation occurred in 11 patients of whom nine had a left frontal epileptogenic zone ($p < 0.01$).
- Ictal vocalisation could be an additional lateralising sign in frontal lobe epilepsy.
- Vocalisation at a subverbal level also shows a left hemispheric dominance in humans.

J Neurol Neurosurg Psychiatry 2000; 69(12):244-7; Januszky J, Fogarasi A, Jokeit H, Ebner A; Epileptologie-Centrum Bethel, Maria Krankenhaus, Marsweg 21, Bielefeld 33617, Germany.

Ictal Vomiting

- 31 episodes of ictal vomiting in nine patients (four patients with subdural electrode)
- Amnesia for the episode occurred in eight of the nine patients.
- Interictal epileptiform abnormalities were maximal in the right temporal region in seven patients and bitemporal in two.
- Ictal epileptiform abnormalities were lateralized to the right hemisphere and involved temporal lobe structures in all patients.
- Three of four patients recorded with subdural electrode arrays were seizure-free following right temporal lobectomy, and the fourth continues to have ictus emeticus at a reduced rate.
- Two features that help delineate paroxysmal vomiting as an ictal event are (1) patient unawareness of vomiting and (2) its association with other ictal phenomena.

Ictus emeticus: an electroclinical analysis.; Neurology 1988 Jul;38(7):1048-52; Kramer RE, Luders H, Goldstick LP, Dinner DS, Morris HH, Lesser RP, Wyllie E; Department of Neurology, Cleveland Clinic Foundation, OH.

Automatisms with preserved responsiveness

- Prospective study
- Responsiveness is impaired when automatisms occur during psychomotor seizures. Automatisms with preserved responsiveness (APRs) are rare
- 123 patients with temporal lobe epilepsy (57 patients [46%] left-sided, 48 patients [39%] right-sided, and 18 patients [15%] bitemporal) with video/EEG monitoring.
- testing responsiveness by asking the patient to respond verbally and to follow motor commands.

Automatisms with preserved responsiveness: a lateralizing sign in psychomotor seizures.; Neurology 1995 Jan;45(1):201-4; Ebner A, Dinner DS, Noachtar S, Luders H

Automatisms with preserved responsiveness

- Seven patients (5.6%) had preserved responsiveness in the presence of prominent automatisms (lip smacking, swallowing).
- In 15 seizures, the responsiveness was adequately tested (3.6 questions per period of automatism).
- Average seizure duration was 71.6 +/- 14.8 seconds (range, 45 to 100 seconds). Average duration of automatisms was 59.5 +/- 13.5 seconds (range, 40 to 80 seconds).

Automatisms with preserved responsiveness

- Ictal EEG was localized over the right temporal area in nine seizures, over the right hemisphere in five, and was nonlocalizable in one seizure.
- APRs never occurred in left-sided psychomotor seizures and occurred in 10% of the right temporal cases.
- In conclusion, APRs reliably lateralized to the right side in temporal lobe epilepsy.

Accuracy & interobserver variability

Table 1. Frequency of lateralizing signs, kappa values, and positive predictive values

Sign	Patients (seizures)	Frequency	Kappa	Positive predictive value
Version	17 (37)	45% (31-58)	0.76	94% (84-100)
Dystonic posturing	14 (29)	37% (24-50)	0.47	80% (61-100)
Mouth deviation	13 (26)	34% (22-47)	0.83	92% (82-100)
Head turning (nonverbal)	10 (26)	26% (14-38)	0.83	80% (59-100)
Postictal dysnomia	8 (23)	21% (10-32)	0.89	100% (*)
Unilateral automatisms (upper extremity)	8 (20)	21% (10-32)	0.65	100% (*)
Ictal speech	6 (13)	16% (6-25)	0.75	83% (58-100)
Overall	30 (110)	78% (67-89)	0.68	94% (87-100)

Figures in parentheses in the third and fifth columns refer to 90% confidence intervals. Asterisks denote that confidence intervals cannot be meaningfully constructed as the proportion of errors is vanishingly small.

Lateralizing signs in intractable partial epilepsy: blinded multiple-observer analysis. *Neurology* 1993 Dec;43(12):2519-25 ; Chee MW, Kotagal P, Van Ness PC, Gragg L, Murphy D, Luders HO; Department of Neurology, Cleveland Clinic Foundation, OH 44195.

Accuracy & interobserver variability

- The epileptogenic region (ER) was lateralized by analyzing lateralizing signs in 78% of patients; positive predictive value (PPV) was 94% (90% CI = 87% to 100%). Overall kappa was 0.68.
- Signs were considered present if seen by two or more observers.
- Forty-five percent had version, ie, forced and sustained head deviation (kappa = 0.76, PPV = 94%);
- 37% had dystonic posturing of the upper extremity (kappa = 0.47, PPV = 93%);
- 34% had unilateral mouth deviation (kappa = 0.83, PPV = 92%). These signs indicated a contralateral ER.
- Twenty-one percent had unilateral upper extremity automatisms, all ipsilateral to the ER (kappa = 0.65, PPV = 100%);

Lateralizing signs in intractable partial epilepsy: blinded multiple-observer analysis. *Neurology* 1993 Dec;43(12):2519-25 ; Chee MW, Kotagal P, Van Ness PC, Gragg L, Murphy D, Luders HO; Department of Neurology, Cleveland Clinic Foundation, OH 44195.

Accuracy & interobserver variability

- 21% had postictal dysnomia, indicating a dominant-hemisphere ER (kappa = 0.89, PPV = 100%);
- 16% had ictal speech, usually indicating a nondominant-hemisphere ER (kappa = 0.75, PPV = 83%).
- Dystonic posturing, postictal dysnomia, ictal speech, and unilateral upper extremity automatisms may indicate a higher probability of temporal lobe epilepsy.
- Analysis of lateralizing signs shows good interobserver agreement and provides useful clinical information.