Epileptic seizure semilogy; case-based learning

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- Temporal lobe epilepsy
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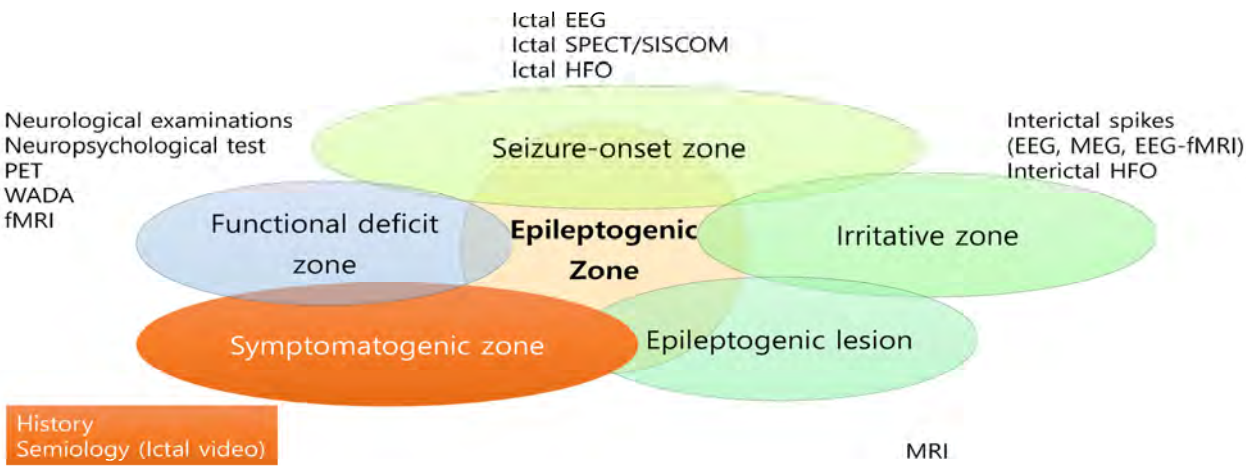

Seizure type	Subtype	Symptomatogenic zone[a]	Lateralization	Epilepsy syndrome[b]
Auras	Somatosensory	Primary somatosensory cortex (areas 1,2, and 3b)	CL[c]	PLE
		Secondary somatosensory areas (parietal operculum/SSII)	IPSI (if unilateral)	PLE, TLE
		SSMA	CL (mostly)	PLE, FLE
	Simple visual	Primary visual cortex (areas 17, 18, and 19)	CL	OLE
	Complex visual	Temporo-occipital junction and basal temporal cortex	CL (if unilateral)	TLE, OLE
	Simple auditory	Primary auditory cortex (area 41)	CL (if unilateral)	TLE
	Complex auditory	Auditory association cortex (areas 42 and 22)	CL (if unilateral)	TLE
	Vertiginous	Temporo-occipital junction	NonLAT (often right)	TLE
	Olfactory	Orbitofrontal region, amygdala, and insula	NonLAT	MTLE, FLE
	Gustatory	Parietal operculum and basal temporal cortex	NonLAT	TLE
	Autonomic	Insula, amygdala, anterior cingulum, and SSMA	NonLAT	TLE, FLE
	Abdominal	Anterior insula, frontal operculum, mesial temporal lobe, and SSMA	NonLAT	MTLE
	Fear	Amygdala, hippocampus, and mesial frontal lobe	NonLAT	TLE, FLE
	Déjà vu/jamais vu	Uncus, entorhinal cortex, and temporal neocortex	NonLAT (often ND)	TLE
	Multisensorial	Mesiobasal limbic cortex, temporal neocortex, TPO junction	NonLAT	TLE, PLE
	Cephalic/whole body	Amygdala, entorhinal cortex, and temporal neocortex/SSII and SSMA	NonLAT	NTLE, FLE
Simple motor	Myoclonic/negative myoclonus	Primary motor cortex (area 4) and premotor cortex (area 6)/primary somatosensory area	CL (if unilateral)	FLE
	Clonic	Primary motor cortex, premotor cortex, and SSMA	CL	FLE
	Tonic	Primary motor cortex and SSMA	CL (if unilateral)	FLE
Complex motor	Hypermotor	Anterior cingulum, orbitofrontal region, frontopolar region, opercular–insular cortex, and medial intermediate frontal area	NonLAT	FLE
	Automotor	Mesial temporal and anterior cingulum	NonLAT	TLE, FLE
	Gelastic	Hypothalamus, anteromesial frontal region, and basal temporal area	NonLAT	FLE, TLE
Dialeptic		Limbic temporal structures, cingulum, intermediate frontal (area 8) and orbitofrontal areas	NonLAT	
Autonomic	Tachycardia/ hyperventilation	Amygdala, insula, anterior cingulum, and medial prefrontal cortex	NonLAT (often right)	TLE
	Pilorection		IPSI	TLE
	Mydriasis		IPSI (if unilateral)	TOLE

[a] Typical symptomatogenic zones are provided.
[b] Common focal epilepsy syndromes.
[c] CL, contralateral; D, dominant; FLE, frontal lobe epilepsy; IPSI, ipsilateral; ND, nondominant; NonLAT, nonlateralizing; OLE, occipital lobe epilepsy; PLE, parietal lobe epilepsy; TLE, temporal lobe epilepsy; SSMA, supplementary sensorimotor area epilepsy; TOLE, temporo-occipital lobe epilepsy; TPO junction, temporo-parieto-occipital junction.

Foldvary-Schaefer (2011) Epilepsy and Behavior

Ictal sign	Subtype	Symptomatogenic zone or mechanism[a]	Lateralization	Epilepsy syndrome[b]
Motor signs in complex motor seizures	Dystonic limb posturing	Activation of basal ganglia	CL[c]	TLE, FLE
	Tonic posturing	Activation of SSMA, basal ganglia, cingulum, and primary motor cortex	CL	FLE, TLE
	Immobile limb	Activation of negative motor areas or exhaustion of primary motor or premotor cortex	CL	TLE
	Head turning	Exhaustion of epileptogenic hemisphere, seizures propagate to basal ganglia, or neglect of CL space	IPSI	TLE
	Facial alterations	Activation of emotional network (amygdala, prefrontal cortex, hypothalamus, orbitofrontal region, insula) or emotional facial movements in cingulum	CL (if facial weakness)	TLE
	Eye version	Frontal eye fields (area 8) and extrastriate cortex (area 19)	CL	
	Unilateral eye blinking	Mesial temporal structures	IPSI	
	Nose wiping	Ictal olfactory hallucinations, increased nasal secretions, or CL postictal immobile limb	IPSI	MTLE
Nondominant temporal signs	Automatisms with preserved responsiveness	Non-speech-dominant temporal lobe and anterior cingulum	ND	TLE, FLE
	Ictal vomiting	Mesial temporal structures, insula, and mesial frontal regions	ND	TLE
	Ictal splitting	Complex automatisms, excessive salivation, or bad mouth sensations	ND	TLE
	Ictal urinary urge	Activation of central bladder control	ND	TLE
	Peri-ictal water drinking	Hypothalamic involvement	ND	TLE
	Ictal/postictal cough	Increased secretions or direct activation of central autonomic system	ND	TLE
	Unilateral ear plugging	Superior temporal gyrus	CL	TLE
Signs during secondary generalized tonic–clonic seizures	Head version	Premotor area (areas 6 and 8)	CL	FLE, TLE
	Asymmetric tonic limb posturing	SSMA and precentral area	CL	TLE, FLE
	Asymmetric ending of clonic jerks	Exhaustion of hemisphere of seizure onset	IPSI	
Language manifestation	Ictal/postictal aphasia	Anterior and posterior language areas	D	TLE
	Ictal speech	Inhibition of D hemisphere or overexcitement of ND hemisphere	ND	TLE

Autonomic activation of respiratory secretions

- Postictal coughing and noserubbing coexist in temporal lobe epilepsy (Neurology, 2000)
- Postictal nose wiping
  - Localizing value in TLE: 51% vs. 12%, p=0.001 (Epileptic disorders, 2002)
  - Lateralizing value: Ipsilateral to the hand, 86.5% (Neurology, 1998)
- Ictal/postictal cough (Seizure, 2004)
  - Localizing value (-)
  - Lateralizing value (onset-Lt. 8/41, Rt 2/41, p=0.021)

Rhythmic ictal nonclonic hand(RINCH)

- unilateral, rhythmic or semirhythmic, nonclonic, nontremor motions of the upper extremities resembling stirring, waving, circling, swinging, flaunting, milking, grasping, fist clenching, pill rolling, or(hand) opening—closing motions, occurring during the ictal period of a complex partial seizure (CPS) and lasting more than 5 s.

Table 2 Lateralizing value of RINCH motions in the whole group of patients with TLE and in the subgroups (TLE-HS and TLE-OTH).

RINCH motions	Ipsilateral and/or alternatively ipsilateral/contralateral to seizure onset		Exclusively contralateral to seizure onset	
	Number of patients	Percentage	Number of patients	Percentage
In total	4/24	16.7*	20/24	83.3*
TLE-HS	3/15	20	12/15	80**
TLE-OTH	1/9	11.1	8/9	88.9**

* Two-sided binominal exact test $p = 0.0015$.
** Chi square = 0.32, $p = 0.514$.

Table 3 Lateralizing value of RINCH motions in seizures of patients with TLE and in the subgroups (TLE-HS and TLE-OTH).

RINCH motions	Ipsilateral to seizure onset		Contralateral to seizure onset	
	Number of seizures	Percentage	Number of seizures	Percentage
In total	4/48	8.33*	44/48	91.7*
TLE-HS	3/25	12	22/25	88**
TLE-OTH	1/23	4.3	22/23	95.6**

* Two sided binominal exact test $p < 0.001$.
** Chi-square = 0.92, $p = 0.337$.

Epilepsy Res, 2013

5000 VEEG, 560 temporal resective surgery, All 5 patients: Right temporal

Epilepsia, **40**(1):114–116, 1999
Lippincott Williams & Wilkins, Philadelphia

Brief Communication

Spitting Automatism in Complex Partial Seizures: A Nondominant Temporal Localizing Sign?

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Lateraizing value (-), Localizing value (+)

Seizure (2006) 15, 462–467

ELSEVIER

CASE REPORT

Ictal spitting in left temporal lobe epilepsy: Report of three cases

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SEIZURE

www.elsevier.com/locate/yseiz

Clinical Neurology and Neurosurgery

Case report

Ictal spitting in left temporal lobe epilepsy and fMRI speech lateralization

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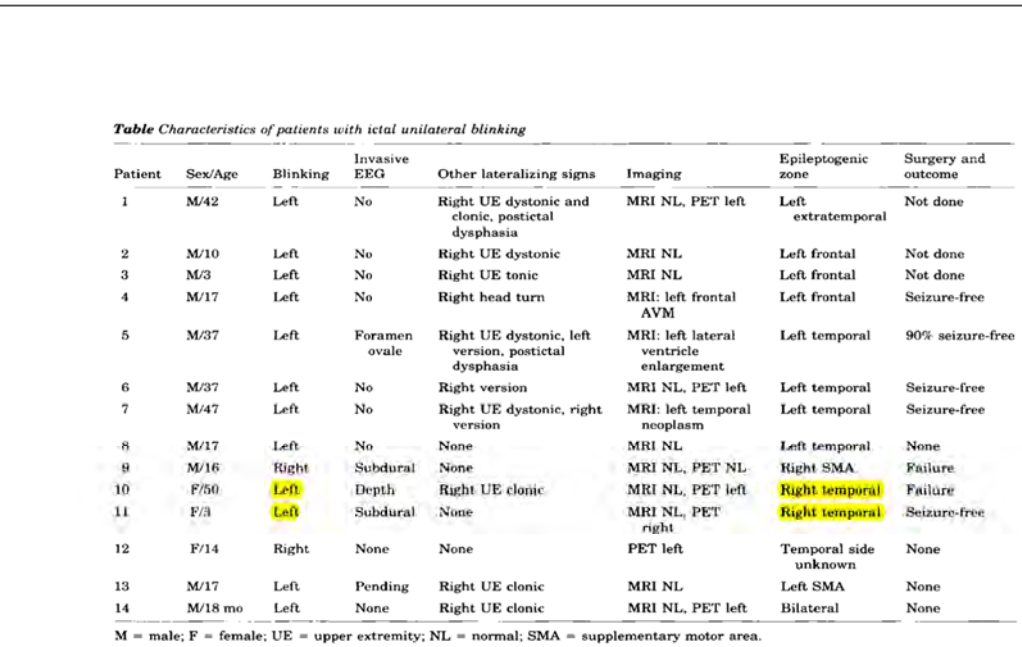


Table *Characteristics of patients with ictal unilateral blinking*

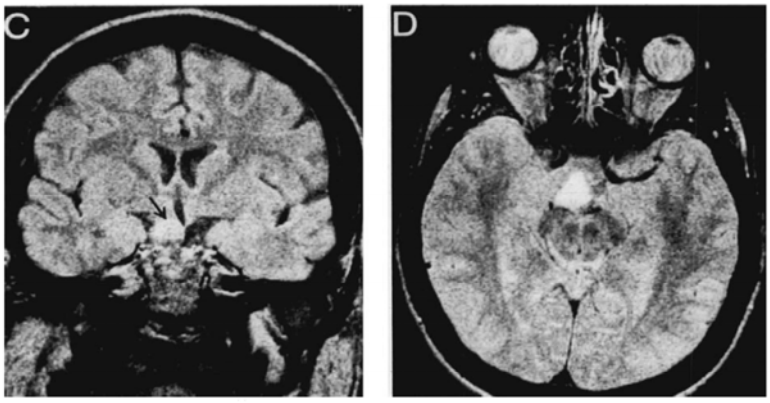
Patient	Sex/Age	Blinking	Invasive EEG	Other lateralizing signs	Imaging	Epileptogenic zone	Surgery and outcome
1	M/42	Left	No	Right UE dystonic and clonic, postictal dysphasia	MRI NL, PET left	Left extratemporal	Not done
2	M/10	Left	No	Right UE dystonic	MRI NL	Left frontal	Not done
3	M/3	Left	No	Right UE tonic	MRI NL	Left frontal	Not done
4	M/17	Left	No	Right head turn	MRI: left frontal AVM	Left frontal	Seizure-free
5	M/37	Left	Foramen ovale	Right UE dystonic, left version, postictal dysphasia	MRI: left lateral ventricle enlargement	Left temporal	90% seizure-free
6	M/37	Left	No	Right version	MRI NL, PET left	Left temporal	Seizure-free
7	M/47	Left	No	Right UE dystonic, right version	MRI: left temporal neoplasm	Left temporal	Seizure-free
8	M/17	Left	No	None	MRI NL	Left temporal	None
9	M/16	Right	Subdural	None	MRI NL, PET NL	Right SMA	Failure
10	F/50	Left	Depth	Right UE clonic	MRI NL, PET left	Right temporal	Failure
11	F/3	Left	Subdural	None	MRI NL, PET right	Right temporal	Seizure-free
12	F/14	Right	None	None	PET left	Temporal side unknown	None
13	M/17	Left	Pending	Right UE clonic	MRI NL	Left SMA	None
14	M/18 mo	Left	None	Right UE clonic	MRI NL, PET left	Bilateral	None

M = male; F = female; UE = upper extremity; NL = normal; SMA = supplementary motor area.

Lateralizing value (+:ipsilateral), Localizing value (-)

Neurology, 1996

Hypothalamic hamartoma



Berkovic, Ann Neurol 1988

No	Age (sex)	Age at onset of epilepsy (years)	Type of epilepsy/ presumed epileptogenic zone	Gelastic seizures ongoing: Y/N	MRI lesion	Side of epilepsy (R/L/H/U)	Surgery/radiotherapy	Pathology	Outcome ILAE; (follow-up/years)
1	38 (M)	30	Mesial TLE	Y[a]	Right HS	R	Patient declined surgery	N/A	N/A
2	40 (M)	2	Hypothalamic	Y[a]	HH	H	Gamma knife recommended; lost to follow-up	N/A	N/A
3	44 (M)	12	Mesial TLE	Y[a]	Left HS	L	L temporal lobectomy	HS	1 (5)
4	25 (F)	15	Undetermined	N	Right temporal FCD; HH	U	No surgery; infrequent seizures	N/A	N/A
5	35 (M)	11	Hypothalamic	N	HH	H	Gamma knife	N/A	5 (2)
6	23 (F)	2	Hypothalamic	Y[a]	HH	H	Gamma knife recommended; lost to follow-up	N/A	N/A
7	42 (M)	8	Hypothalamic	N	HH	H	Gamma knife	N/A	5 (3)
8	31 (F)	2	Hypothalamic	Y	HH	H	Gamma knife	N/A	5 (3)
9	27 (F)	15	Neocortical TLE	Y[a]	No lesion	L	No surgery; lost to follow up	N/A	N/A
10	38 (M)	18	Undetermined	Y[a]	No lesion	L	No surgery; no clear focus identified	N/A	N/A
11	35 (M)	19	Mesial TLE	Y[a]	No lesion	L	No surgical candidate (drug trials ongoing)	N/A	N/A
12	19 (F)	11	Hypothalamic	Y[a]	HH	U	Gamma knife	N/A	1 (2)
13	36 (M)[b]		Mesial TLE	N	L HS	L	Left temporal lobectomy	HS	1 (1)
14	26 (M)[b]		Hypothalamic	Y	HH	H	Gamma knife recommended; patient denied	N/A	N/A
15	38 (M)	14	FLE	Y[a]	No lesion	L	Presurgical investigations ongoing	N/A	N/A
16	23 (M)	7	Multifocal	Y[a]	No lesion	U	No surgery; no clear focus identified	N/A	N/A
17	35 (F)	12	Unspecified TLE	Y	No lesion	R	No surgery; patient does not want to proceed to intracranial investigations	N/A	N/A
18	53 (F)	48	L hemispheric	Y[a]	No lesion	L	No surgery; no clear focus identified	N/A	N/A
19	37 (F)	15	PLE	Y[a]	R FCD	R	Not yet; on waiting list	N/A	N/A

Lateralizing(-)
Localizing
- TLE (m/c), but...

Kovac et al.
Epilepsia 2015

Lateralizing value(+)
Localizing value (often temporal lobe)

TABLE 1. *Number of TLE patients with or without ictal speech manifestations in nondominant and dominant lobe groups*

Seizure origin	Total no. of patients	Ictal verbalization	Ictal vocalization[a]	No speech manifestations
Nondominant	44	9[b]	13	22
Dominant	24	1	9	14
Total	68 (100%)	10 (14.7%)	22 (32.4%)	36 (52.9%)

TLE, temporal lobe epilepsy.
Numbers in parentheses are percentages of total patients.
[a] Numbers in this group do not include 6 patients who also had ictal verbalization.
[b] Nine of 10 = 90%, $p = 0.049$.

Epilepsia, 1996

Table 3. Speech Manifestations of Temporal Lobe Seizures

Type of Speech Manifestation	No. of Patients[a]		
	Dominant	Nondominant	Total
Vocalization	10 (22)	7 (14)	17 (36)
Normal speech (total)	2 (3)	10 (22)	12 (25)
Repetitive	1 (1)	6 (10)	7 (11)
Nonrepetitive	1 (2)	4 (12)	5 (14)
Abnormal speech (total)	13 (34)	5 (7)	18 (41)
Speech arrest	1 (1)	2 (2)	3 (3)
Dysarthria	1 (1)		1 (1)
Dysphasias	12 (27)	2 (3)	14 (30)
Nonidentifiable speech	3 (6)	3 (4)	6 (10)
Total	16 (48)	19 (52)	35 (100)

[a]Numbers in parentheses are number of seizures.

Ann Neurol 1989

Epilepsia, **44**(12):1562–1567, 2003
Blackwell Publishing, Inc.

The Significance of Ear Plugging in Localization-related Epilepsy

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Ear plugging

Hypermotor seizure can occur in TLE

	Age (years)					Seizure semiology		Surgical removal				
Gender	Seizure onset	Surgery	Seizure frequency/month	Nocturnal seizures	MRI abnormality	Aura	Manifestations	Site	Mesial F	Histology	Followup (months)	Outcom
M	5	7	60–300	Most	No	No	2+4	R-F	Yes	FCDIIA	14	F
M	2	19	>300	Most	R-F	No	1+3	R-F	Yes	FCDIIA	12	U
			60–300	Most	R-orbital	Palpitation	1+3	R-F	Yes	FCDIIB	12	F
M	9	22	60–120	Most	No	Upset, fear	1+3	R-F	No	FCDIIA	12	F
F	3	15	6–10	Less	L-T	Fear	1+2+3	L-T	No	Gangliogliomas	12	F
F	3	18	60–300	All	No	No	1+2+3	L-F	Yes	FCDIIB	60	F
M	0.5	33	60–120	Most	No	Palpitation, dyspnea	1+2+4	R-F	Yes	MMCD	48	F
F	1	32	60–300	Most	L-F	Palpitation	1+2+4	L-F	No	FCDIA	48	U
M	2	6	60–150	All	No	No	1+2+3	L-F	Yes	FCDIIB	36	U
F	4	6	60–180	All	No	No	1+2+4	L-F	No	Heterotopia	36	F
M	6	24	10–60	Most	No	Palpitation, dyspnea	1+2+4	L-F	Yes	FCDIIB	24	F
F	0	10	60–200	Most	No	Fear	2+4	L-F	No	FCDIIA	12	U
M	10	21	60–100	All	No	Dyspnea	1+3	R-F	No	FCDIB	12	F
M	15	19	30–60	Most	L-F	Dizziness	1+3	L-F	Yes	Cysticercosis	24	F
M	7	12	100–150	Most	No	Fear	1+3	R-F	Yes	FCDIA	24	F
F	6	25	20–60	Less	No	Tasteless	2+4	R-F	Yes	FCDIIB	12	F
M	13	16	60–300	Most	R-F	No	1+4	L-F	Yes	FCDIB	24	U
M	5	10	60–300	All	No	Fear	1+2+3	L-F	Yes	FCDIIA	24	F
M	15	25	20–60	Most	No	Fear	1+2+4	R-F	Yes	FCDIB	12	U
M	5	12	60–300	Most	L-F	No	1+2+4	L-F	Yes	FCDIB	12	F
F	1	5	60–300	Equal	No	Fear	2+4	L-F	No	FCDIIB	12	U
M	6	25	60–300	Most	No	Dizziness	1+3	R-F	Yes	FCDIIA	12	F
M	10	19	60–120	All	No	No	1+3	L-F	Yes	FCDIB	60	F
M	5	17	10–20	Most	R-Hippocampus	Epigastric sensation	1+2+3	R-T	No	Hippocampal sclerosis	12	F

Epilepsia, 2010

Temporal lobe origin is common in patients who have undergone epilepsy surgery for hypermotor seizures

Variables		Number (percentage)
Male gender		11 (47.83%)
Predominantly nocturnal seizures		8 (34.7%)
Number of AEDs at surgery:	1	7 (30%)
	2	11 (47.8%)
	3	3 (13.0%)
	4	2 (8.7%)
Ictal onset lateralization: right		15 (65.2%)
Left		5 (21.7%)
Indeterminate		3 (13%)
Intracranial monitoring done: yes		20 (86.9%)
MRI normal		15 (65%)
Surgical resection site:	Anterior temporal/selective amygdalohippocampectomy	14 (60.8%)
	Cingulate	4 (17%)
	Orbitofrontal	4 (17%)
	Temporoparietal	1 (4.3%)
Histology of resected tissue:	Gliosis	11 (47.8%)
	Focal cortical dysplasia	4 (17%)
	Hippocampal sclerosis	4 (17%)
	Cavernous malformation	1 (4.3%)
	Hamartoma and pilocytic astrocytoma	2 (8.6%)
	Normal	1 (4.3%)
Seizure outcome Engel classification:	I	14 (60.8%)
	II	3 (13%)
	III	3 (13%)
	IV	3 (13%)
Continuous variables	Median (lower quartile–upper quartile)	
Epilepsy onset age in years	9 (4–19)	
Seizure frequency per month	16 (6–60)	
Age at surgery in years	30 (23–42)	
Follow-up duration postop in months	42 (27–133)	
Number of seizures recorded in EMU	10 (6–13)	

Epilepsy Behav, 2016

Asymmetric seizure termination

Table 2. Positive predictive value in temporal lobe epilepsy and frontal lobe epilepsy

		TLE					FLE				
Sign		N (%)	Ipsilat	Contralat	Ipsi + contralat	PPV	N (%)	Ipsilat	Contralat	Ipsi + contralat	PPV
AST	pt	26 (63)	18/41	6/41	2/41	0.75[a]	17 (71)	11/24	5/24	1/24	0.69[d]
	sz	43 (47)	32/92	11/92		0.74[b]	28 (60)	21/47	7/47		0.75[b]
Version	pt	36 (88)	3/41	33/41		0.92[c]	15 (63)	1/24	14/24		0.93[b]
	sz	64 (70)	4/92	60/92		0.92[c]	28 (60)	2/47	26/47		0.93[c]
Figure 4	pt	22 (54)	3/41	19/41		0.86[c]	10 (42)	4/24	6/24		0.60[d]
	sz	34 (37)	4/92	30/92		0.88[c]	16 (34)	8/47	8/47		0.50[d]

[a]$p < 0.05$; [b]$p < 0.01$; [c]$p \leq 0.001$; [d]p = ns.
TLE, temporal lobe epilepsy; FLE, frontal lobe epilepsy; PPV, positive predictive value; AST, asymmetric seizure termination; pt, patients; sz, seizures.

Lateralizing (-), Localizing (-)

Author	Age/sex	Onset (y)	Hand/ speech	Seizure semiology	Interictal V-EEG	Ictal V-EEG	Intracranial exploration	Findings (ictal vomiting)	Stimulation	Etiology	Imaging	Treatment	F-U
Kramer et al. [5]	31/F	NR	NR	Staring, swallowing followed by retching and vomiting	R-T epil abn	R-T	Grid: R-T and F and P areas	MT spreading to lateral T	Performed (+): R T ant basal (abdominal sensation)	Gliosis and neuronal heterotopia	MR Normal	R-T lobectomy including mesial structures	Engel Ia
	24/F	NR	NR	Staring, L arm automatism, eye blinking, retching and vomiting	R-T epil abn	NR	Grid: R-T and F and P areas	MT spreading to lateral T	Performed (−)	Gliosis and neuronal heterotopia	CT Normal	R-T lobectomy including mesial structures	Engel Ia
	11/F	NR	NR	Staring, retching, vomiting followed by screaming, L eye and limbs version	R-T epil abn	R-T	Grid: R-T and F and P areas	M and basal T	NP	Gliosis and neuronal heterotopia	CT Normal	R-T lobectomy including mesial structures	Engel III
	33/M	NR	NR	Staring, chewing followed by retching	R-T epil abn	NR	Grid: R-T and F and P areas	MT spreading to lateral T	Performed (−)	Gliosis and neuronal heterotopia	CT Normal	R-T lobectomy including mesial structures	Engel Ia
Devinsky et al. [10]	47/F	10	L-hem dom	Impairment of consciousness, staring, oral and hand automatisms, vomiting	SW over the L ant T	R-T	Depth: F Bil and T Bil (2 each side)	R MT	NR	NR	MR ↓ L Hip	L-T lobectomy	Engel Ia
	18/F	15	L-h Bil language R dom	Oral automatisms and gagging sounds; nausea and vomiting, occasionally SG	L-T epil abn	L-T	Grid: L-T and F and P areas	LT strip (mesial) then lateral involvement	NR	NR	MR CC agenesis ventriculomegaly, L > R	L-T lobectomy with hippocampectomy	Engel Ia
Schäuble et al. [14]	18/F	7	R-h L-hem dom	Staring, fearful facial expression, then gagging and vomiting	L-T epil abn	NI	Depth: Bil MT	L anterior T	NR	Grade 2 fibrillary astrocytoma	MR L MT tumor	Ant L-T lobectomy (amygdalohippocampectomy) and tumor excision	Engel Ia
Catenoix et al. [17]	26/M	10	R-h/NR	Abdominal, and thoracic constriction, hypersalivation, nausea, laryngeal constriction, vomiting	Normal	NI	Depth: T and I-O cortex (10 L, 2 R)	Bil I	Performed (+): L ant I and L amyg (nausea)	Type I FCD	MR Normal	R-T lobectomy, [Amyg]	Engel Ia
Present case	**4.5/F**	**3**	**R-h/NR**	**Grimacing, oral automatisms, R head orientation, retching; episodes of ictal vomiting**	**R-T epil abn**	**R-T**	**Depth: T and I-O cortex (7 R)**	**R T (mesial) (amyg)**	**Performed (+): mesial R ant T (vomiting)**	**Type I FCD and HS (FCD IIIa)**	**MR ↓ R Hip**	**R-T lobectomy with hippocampectomy**	**Engel Ia**

M = male, F = female, y = years, Hand: handedness, speech: speech dominance, V = video, NR = not reported, R = right, L = left, hem = hemisphere, dom = dominance, bil = bilateral, h = handed, SG = secondary generalization, T = temporal, epil = epileptic, abn = abnormality, NI = not identified, F = frontal, P = parietal, I = insula, O = opercular, MT = mesiotemporal, amyg = amygdala, HS = hippocampal sclerosis, MR = magnetic resonance, CT = computed tomography, ↓ = decrease, FCD = focal cortical dysplasia, (+) = positive, (−) = negative, F-U = follow-up.

Epilepsy Behav 2015

Seizure type	Subtype	Symptomatogenic zone[a]	Lateralization	Epilepsy syndrome[b]
Auras	Somatosensory	Primary somatosensory cortex (areas 1,2, and 3b)	CL[c]	PLE
		Secondary somatosensory areas (parietal operculum/SSII)	IPSI (if unilateral)	PLE, TLE
		SSMA	CL (mostly)	PLE, FLE
	Simple visual	Primary visual cortex (areas 17, 18, and 19)	CL	OLE
	Complex visual	Temporo-occipital junction and basal temporal cortex	CL (if unilateral)	TLE, OLE
	Simple auditory	Primary auditory cortex (area 41)	CL (if unilateral)	TLE
	Complex auditory	Auditory association cortex (areas 42 and 22)	CL (if unilateral)	TLE
	Vertiginous	Temporo-occipital junction	NonLAT (often right)	TLE
	Olfactory	Orbitofrontal region, amygdala, and insula	NonLAT	MTLE, FLE
	Gustatory	Parietal operculum and basal temporal cortex	NonLAT	TLE
	Autonomic	Insula, amygdala, anterior cingulum, and SSMA	NonLAT	TLE, FLE
	Abdominal	Anterior insula, frontal operculum, mesial temporal lobe, and SSMA	NonLAT	MTLE
	Fear	Amygdala, hippocampus, and mesial frontal lobe	NonLAT	TLE, FLE
	Déjà vu/jamais vu	Uncus, entorhinal cortex, and temporal neocortex	NonLAT (often ND)	TLE
	Multisensorial	Mesiobasal limbic cortex, temporal neocortex, TPO junction	NonLAT	TLE, PLE
	Cephalic/whole body	Amygdala, entorhinal cortex, and temporal neocortex/SSII and SSMA	NonLAT	NTLE, FLE
Simple motor	Myoclonic/negative myoclonus	Primary motor cortex (area 4) and premotor cortex (area 6)/primary somatosensory area	CL (if unilateral)	FLE
	Clonic	Primary motor cortex, premotor cortex, and SSMA	CL	FLE
	Tonic	Primary motor cortex and SSMA	CL (if unilateral)	FLE
Complex motor	Hypermotor	Anterior cingulum, orbitofrontal region, frontopolar region, opercular–insular cortex, and medial intermediate frontal area	NonLAT	FLE
	Automotor	Mesial temporal and anterior cingulum	NonLAT	TLE, FLE
	Gelastic	Hypothalamus, anteromesial frontal region, and basal temporal area	NonLAT	FLE, TLE
Dialeptic		Limbic temporal structures, cingulum, intermediate frontal (area 8) and orbitofrontal areas	NonLAT	
Autonomic	Tachycardia/ hyperventilation	Amygdala, insula, anterior cingulum, and medial prefrontal cortex	NonLAT (often right)	TLE
	Pilorection		IPSI	TLE
	Mydriasis		IPSI (if unilateral)	TOLE

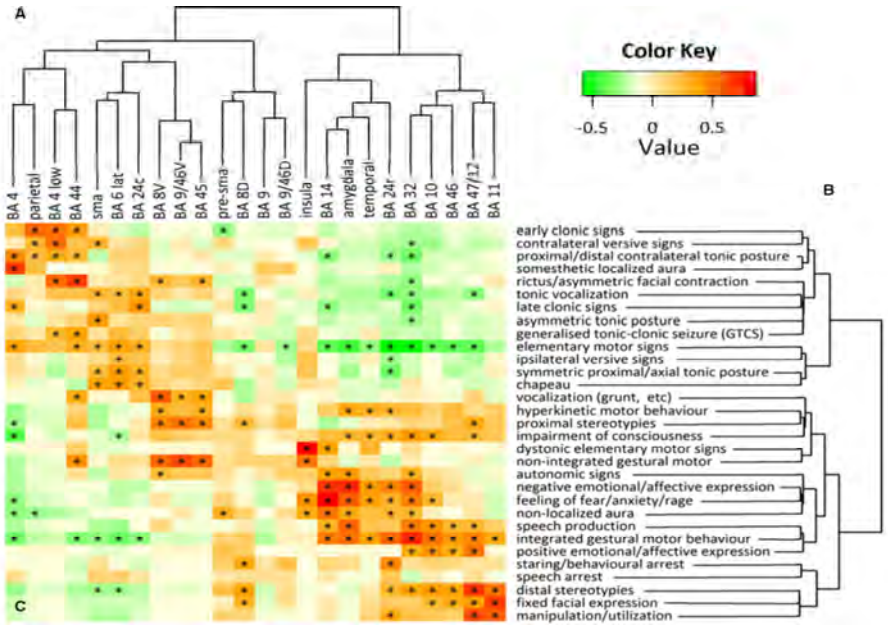
Foldvary-Schaefer (2011) Epilepsy and Behavior

Ictal sign	Subtype	Symptomatogenic zone or mechanism[a]	Lateralization	Epilepsy syndrome[b]
Motor signs in complex motor seizures	Dystonic limb posturing	Activation of basal ganglia	CL[c]	TLE, FLE
	Tonic posturing	Activation of SSMA, basal ganglia, cingulum, and primary motor cortex	CL	FLE, TLE
	Immobile limb	Activation of negative motor areas or exhaustion of primary motor or premotor cortex	CL	TLE
	Head turning	Exhaustion of epileptogenic hemisphere, seizures propagate to basal ganglia, or neglect of CL space	IPSI	TLE
	Facial alterations	Activation of emotional network (amygdala, prefrontal cortex, hypothalamus, orbitofrontal region, insula) or emotional facial movements in cingulum	CL (if facial weakness)	TLE
	Eye version	Frontal eye fields (area 8) and extrastriate cortex (area 19)	CL	
	Unilateral eye blinking	Mesial temporal structures	IPSI	
	Nose wiping	Ictal olfactory hallucinations, increased nasal secretions, or CL postictal immobile limb	IPSI	MTLE
Nondominant temporal signs	Automatisms with preserved responsiveness	Non-speech-dominant temporal lobe and anterior cingulum	ND	TLE, FLE
	Ictal vomiting	Mesial temporal structures, insula, and mesial frontal regions	ND	TLE
	Ictal splitting	Complex automatisms, excessive salivation, or bad mouth sensations	ND	TLE
	Ictal urinary urge	Activation of central bladder control	ND	TLE
	Peri-ictal water drinking	Hypothalamic involvement	ND	TLE
	Ictal/postictal cough	Increased secretions or direct activation of central autonomic system	ND	TLE
	Unilateral ear plugging	Superior temporal gyrus	CL	TLE
Signs during secondary generalized tonic–clonic seizures	Head version	Premotor area (areas 6 and 8)	CL	FLE, TLE
	Asymmetric tonic limb posturing	SSMA and precentral area	CL	TLE, FLE
	Asymmetric ending of clonic jerks	Exhaustion of hemisphere of seizure onset	IPSI	
Language manifestation	Ictal/postictal aphasia	Anterior and posterior language areas	D	TLE
	Ictal speech	Inhibition of D hemisphere or overexcitement of ND hemisphere	ND	TLE

Foldvary-Schaefer (2011) Epilepsy and Behavior

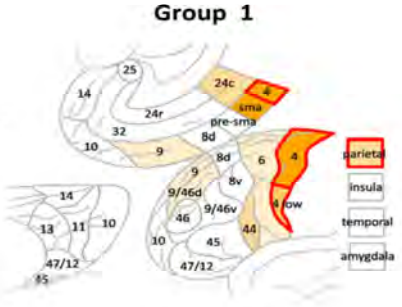
Frontal lobe epilespy

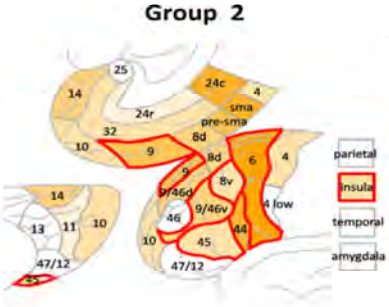
54 FLE patients
SEEG
correlation → PCA



Bonini et al.
Epilepsia 2014

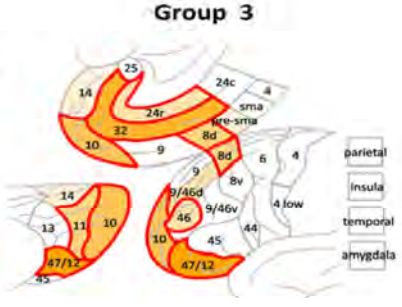
Group 1
- elementary motor sign
- precentral/premotor regions

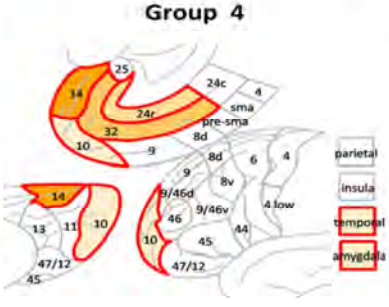




Group 2
- combination of elementary motor signs and nonintegrated gestural motor behavior
- premotor/prefrontal regions

Group 3
- integrated gestural motor behavior with distal stereotypies
- anterior lateral/medial prefrontal regions





Group 4
- fearful behavior
- paralimbic system (ventromedial prefrontal cortex +- anterior temporal structures)

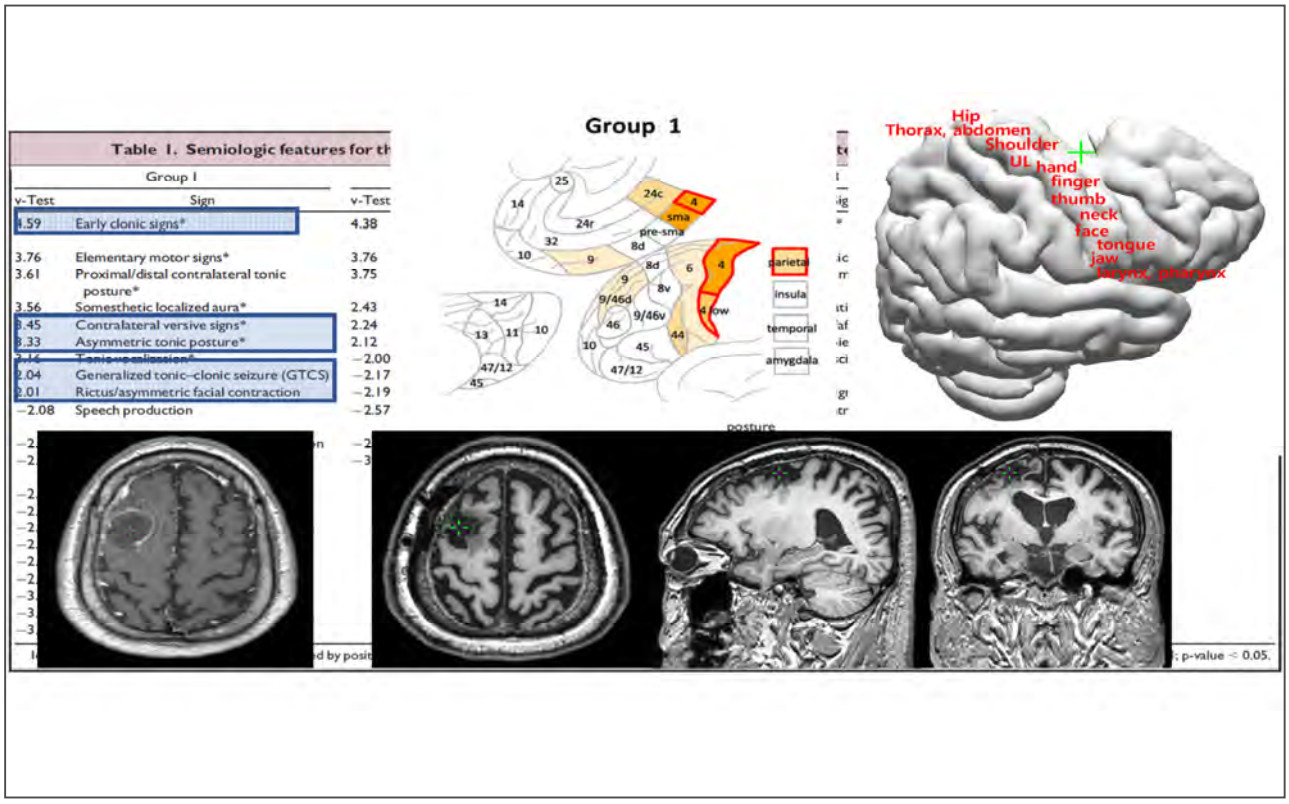


Table 1. Semiologic features for th
Group 1
v-Test
Sign
v-Test
4.59 Early clonic signs* 4.38
3.76 Elementary motor signs* 3.76
3.61 Proximal/distal contralateral tonic posture* 3.75
3.56 Somesthetic localized aura* 2.43
3.45 Contralateral versive signs* 2.24
3.33 Asymmetric tonic posture* 2.12
2.04 Generalized tonic–clonic seizure (GTCS) −2.17
2.01 Rictus/asymmetric facial contraction −2.19
−2.08 Speech production −2.57
Group 1
parietal
insula
temporal
amygdala
Hip
Thorax, abdomen
Shoulder
UL
hand
finger
thumb
neck
face
tongue
jaw
larynx, pharynx
posture
p-value < 0.05.

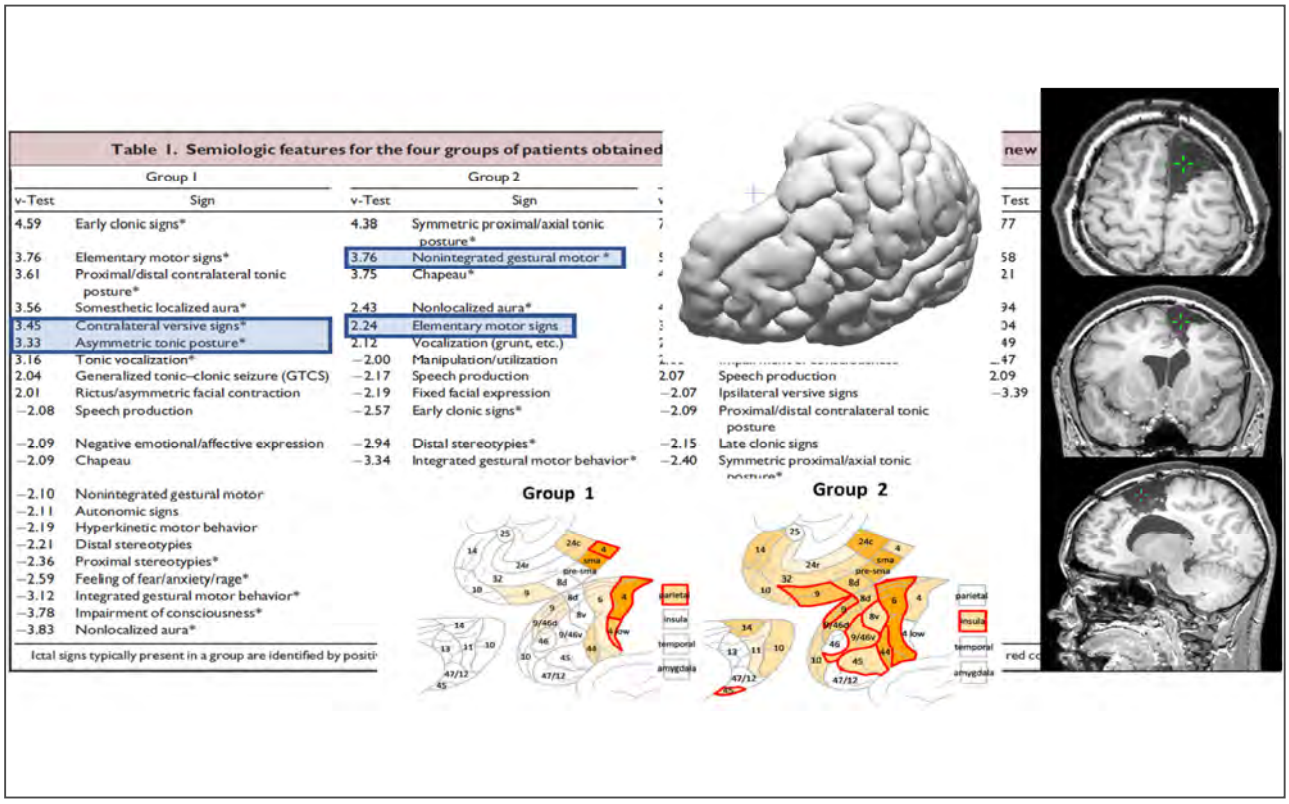
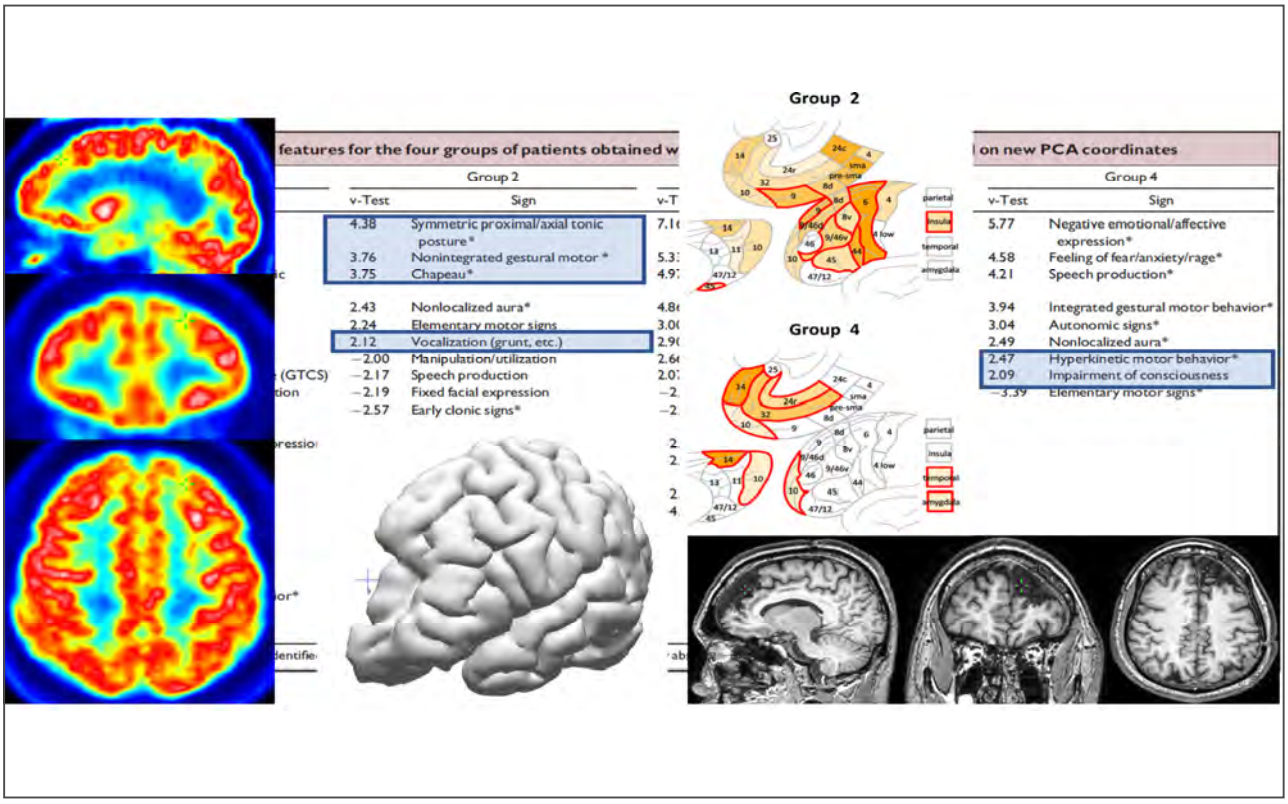


Table 1. Semiologic features for the four groups of patients obtained
Group 1
Group 2
v-Test
Sign
v-Test
Sign
4.59 Early clonic signs* 4.38 Symmetric proximal/axial tonic posture*
3.76 Elementary motor signs* 3.76 Nonintegrated gestural motor *
3.61 Proximal/distal contralateral tonic posture* 3.75 Chapeau*
3.56 Somesthetic localized aura* 2.43 Nonlocalized aura*
3.45 Contralateral versive signs* 2.24 Elementary motor signs
3.33 Asymmetric tonic posture* 2.12 Vocalization (grunt, etc.)
3.16 Tonic vocalization* −2.00 Manipulation/utilization
2.04 Generalized tonic–clonic seizure (GTCS) −2.17 Speech production
2.01 Rictus/asymmetric facial contraction −2.19 Fixed facial expression
−2.08 Speech production −2.57 Early clonic signs*
−2.09 Negative emotional/affective expression −2.94 Distal stereotypies*
−2.09 Chapeau −3.34 Integrated gestural motor behavior*
−2.10 Nonintegrated gestural motor
−2.11 Autonomic signs
−2.19 Hyperkinetic motor behavior
−2.21 Distal stereotypies
−2.36 Proximal stereotypies*
−2.59 Feeling of fear/anxiety/rage*
−3.12 Integrated gestural motor behavior*
−3.78 Impairment of consciousness*
−3.83 Nonlocalized aura*
Ictal signs typically present in a group are identified by positi
2.07 Speech production
−2.07 Ipsilateral versive signs
−2.09 Proximal/distal contralateral tonic posture
−2.15 Late clonic signs
−2.40 Symmetric proximal/axial tonic posture*
Group 1
Group 2
parietal
insula
temporal
amygdala


features for the four groups of patients obtained w
Group 2
v-Test
Sign
4.38 Symmetric proximal/axial tonic posture*
3.76 Nonintegrated gestural motor *
3.75 Chapeau*
2.43 Nonlocalized aura*
2.24 Elementary motor signs
2.12 Vocalization (grunt, etc.)
−2.00 Manipulation/utilization
−2.17 Speech production
−2.19 Fixed facial expression
−2.57 Early clonic signs*
Group 2
Group 4
on new PCA coordinates
Group 4
v-Test
Sign
5.77 Negative emotional/affective expression*
4.58 Feeling of fear/anxiety/rage*
4.21 Speech production*
3.94 Integrated gestural motor behavior*
3.04 Autonomic signs*
2.49 Nonlocalized aura*
2.47 Hyperkinetic motor behavior*
2.09 Impairment of consciousness
Elementary motor signs*

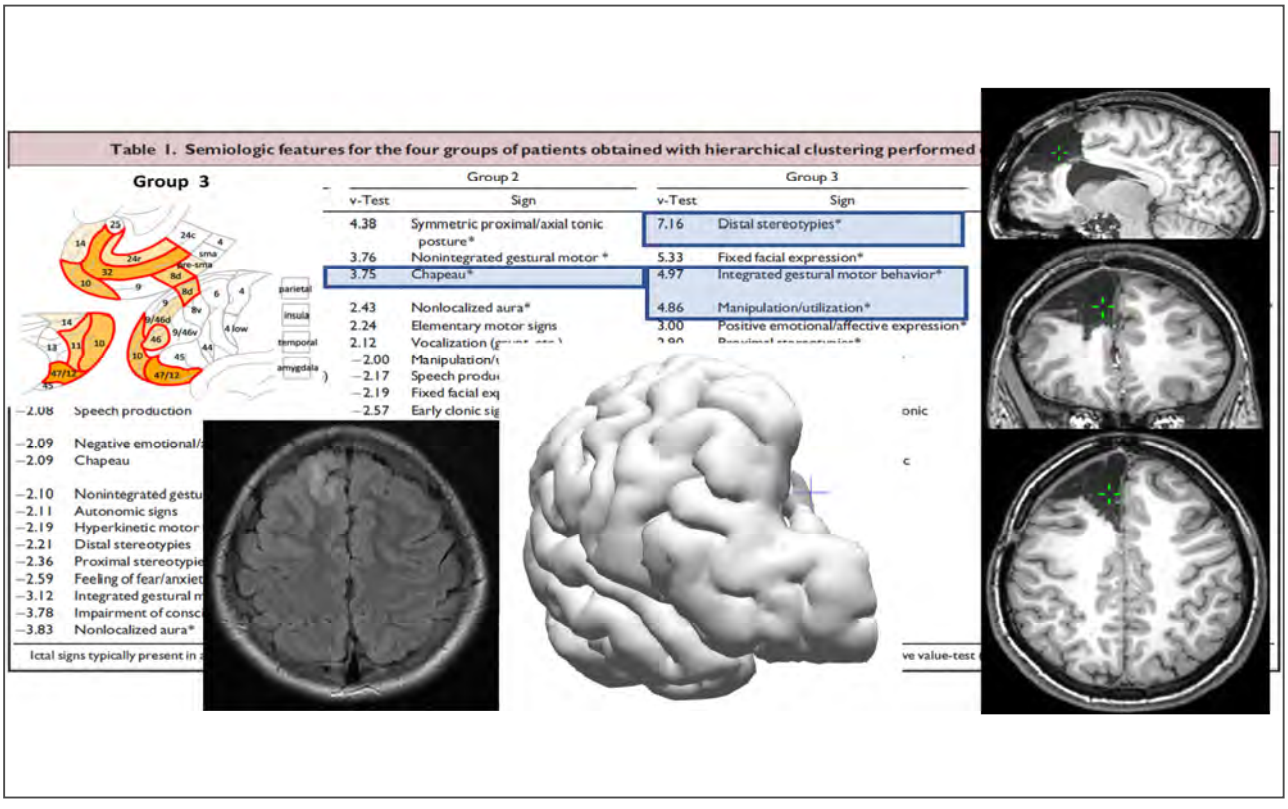
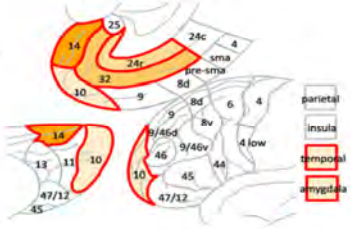


Table 1. Semiologic features for the four groups of patients obtained with hierarchical clustering performed
Group 3
Group 2
Group 3
v-Test
Sign
v-Test
Sign
4.38 Symmetric proximal/axial tonic posture*
7.16 Distal stereotypies*
3.76 Nonintegrated gestural motor *
5.33 Fixed facial expression*
3.75 Chapeau*
4.97 Integrated gestural motor behavior*
4.86 Manipulation/utilization*
2.43 Nonlocalized aura*
2.24 Elementary motor signs
3.00 Positive emotional/affective expression*
2.12 Vocalization
−2.00 Manipulation/
−2.17 Speech produ
−2.19 Fixed facial ex
−2.57 Early clonic si
−2.08 Speech production
−2.09 Negative emotional/
−2.09 Chapeau
−2.10 Nonintegrated gestu
−2.11 Autonomic signs
−2.19 Hyperkinetic motor
−2.21 Distal stereotypies
−2.36 Proximal stereotypie
−2.59 Feeling of fear/anxiet
−3.12 Integrated gestural m
−3.78 Impairment of consc
−3.83 Nonlocalized aura*
ictal signs typically present in
onic
c
ve value-test

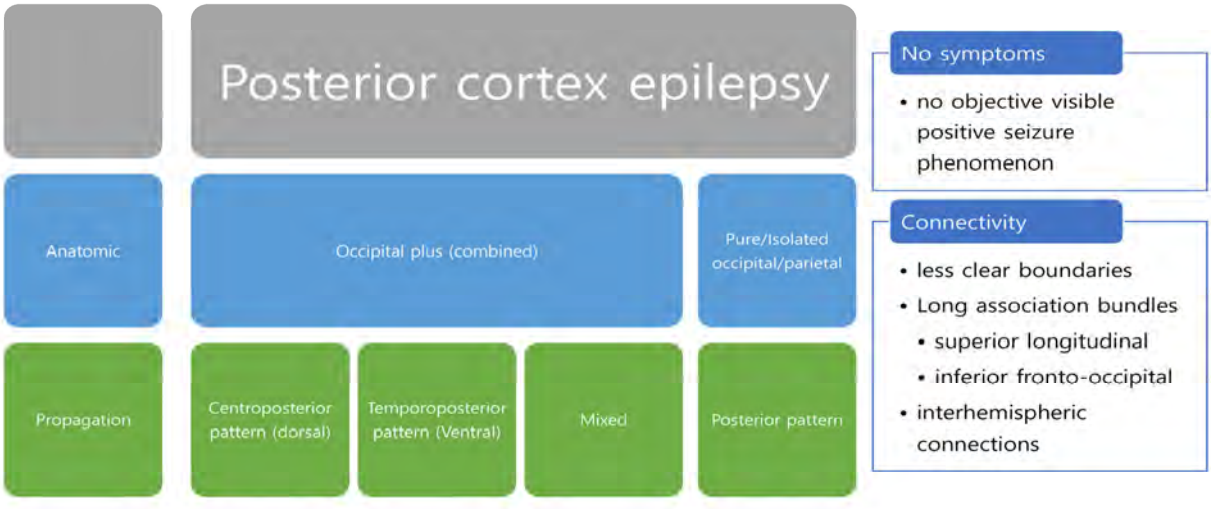
Table 1. Semiologic features for the four groups of patients obtained with hierarchical clustering performed on new PCA coordinates

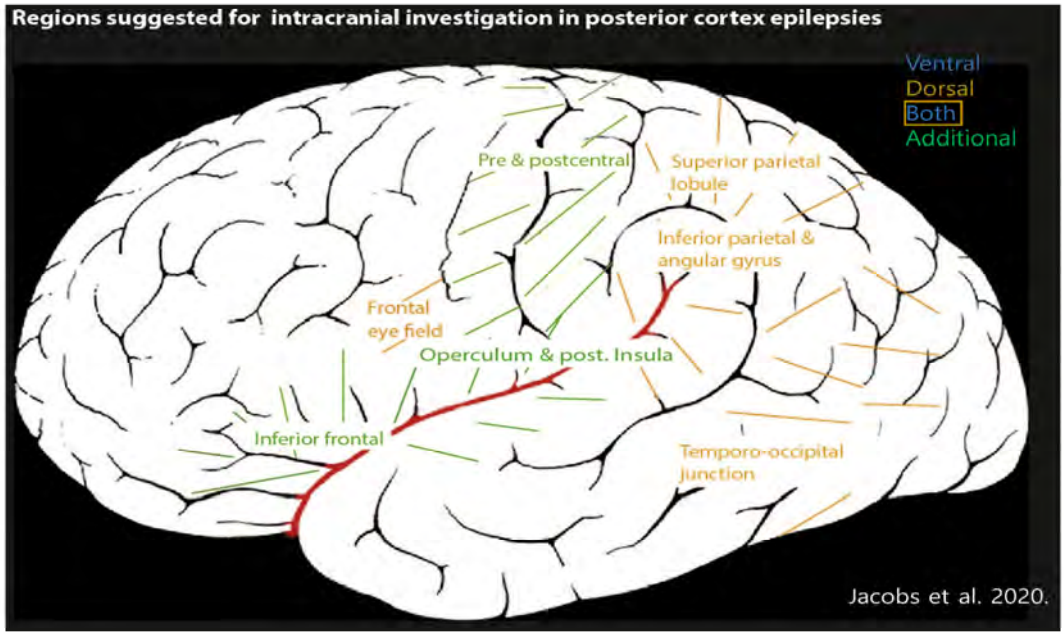
Group 1		Group 2		Group 3		Group 4	
v-Test	Sign	v-Test	Sign	v-Test	Sign	v-Test	Sign
4.59	Early clonic signs*	4.38	Symmetric proximal/axial tonic posture*	7.16	Distal stereotypies*	5.77	Negative emotional/affective expression*
3.76	Elementary motor signs*	3.76	Nonintegrated gestural motor *	5.33	Fixed facial expression*	4.58	Feeling of fear/anxiety/rage*
3.61	Proximal/distal contralateral tonic posture*	3.75	Chapeau*	4.97	Integrated gestural motor behavior*	4.21	Speech production*
3.56	Somesthetic localized aura*	2.43	Nonlocalized aura*	4.86	Manipulation/utilization*	3.94	Integrated gestural motor behavior*
3.45	Contralateral versive signs*	2.24	Elementary motor signs	3.00	Positive emotional/affective expression*	3.04	Autonomic signs*
3.33	Asymmetric tonic posture*	2.12	Vocalization (grunt, etc.)	2.90	Proximal stereotypies*	2.49	Nonlocalized aura*
3.16	Tonic vocalization*	−2.00	Manipulation/utilization	2.66	Impairment of consciousness*	2.47	Hyperkinetic motor behavior*
2.04	Generalized tonic–clonic seizure (GTCS)	−2.17	Speech production			2.09	Impairment of consciousness
2.01	Rictus/asymmetric facial contraction	−2.19	Fixed facial expression			−3.39	Elementary motor signs*
−2.08	Speech production	−2.57	Early clonic signs*				
−2.09	Negative emotional/affective expression	−2.94	Distal stereotypies*				
−2.09	Chapeau	−3.34	Integrated gestural motor				
−2.10	Nonintegrated gestural motor						
−2.11	Autonomic signs						
−2.19	Hyperkinetic motor behavior						
−2.21	Distal stereotypies						
−2.36	Proximal stereotypies*						
−2.59	Feeling of fear/anxiety/rage*						
−3.12	Integrated gestural motor behavior*						
−3.78	Impairment of consciousness*						
−3.83	Nonlocalized aura*						

Group 4



Ictal signs typically present in a group are identified by positive value-test (>2, green colored), whereas typically absent ictal signs are identified by negative value-test (<2, red colored).*p-value < 0.01; p-value < 0.05.




Regions suggested for intracranial investigation in posterior cortex epilepsies
Ventral
Dorsal
Both
Additional
Pre & postcentral
Superior parietal lobule
Inferior parietal & angular gyrus
Frontal eye field
Operculum & post. Insula
Inferior frontal
Temporo-occipital junction
Jacobs et al. 2020.

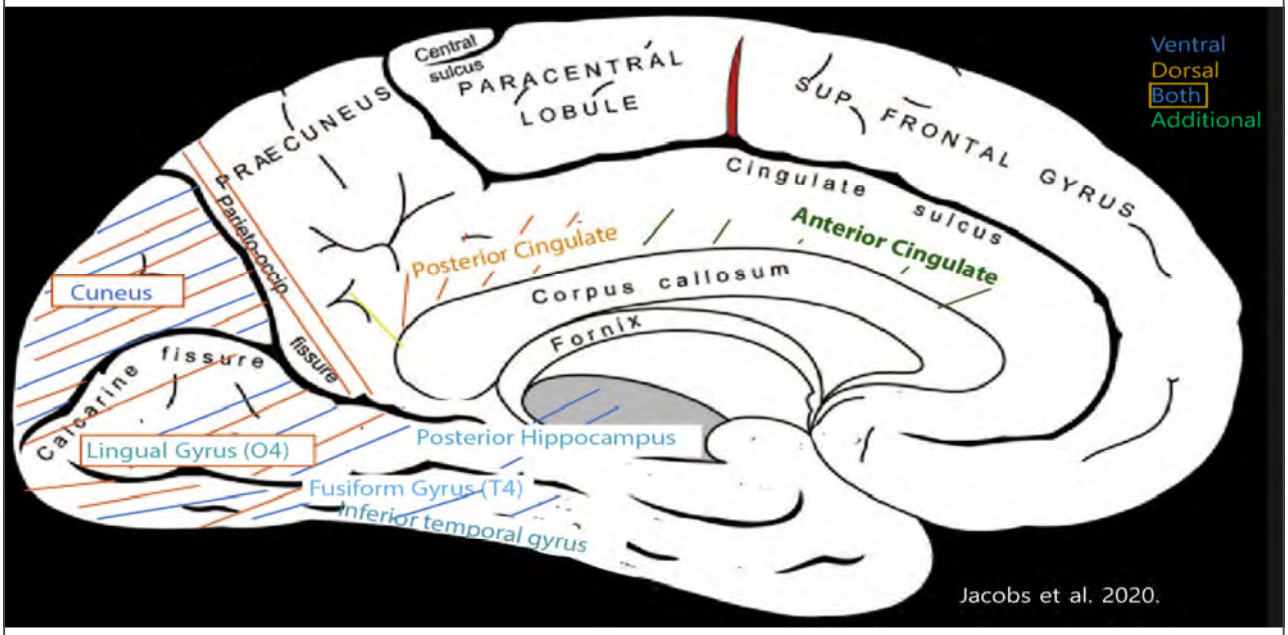

Ventral
Dorsal
Both
Additional
Central sulcus
PARACENTRAL LOBULE
SUP. FRONTAL GYRUS
PRAECUNEUS
Cingulate sulcus
Posterior Cingulate
Anterior Cingulate
Corpus callosum
Fornix
Cuneus
Parietooccip. fissure
Calcarine fissure
Lingual Gyrus (O4)
Posterior Hippocampus
Fusiform Gyrus (T4)
Inferior temporal gyrus
Jacobs et al. 2020.

Table 1
Typical seizure phenomena seen in posterior lobe epilepsy studies

Study	Population & Patient No.	Daily Seizures	Elementary Visual	Visual Complex or Loss	Nonvisual Aura	Temporal Type	Frontal Type	Complex Partial Seizure	Spasms	Generalized Tonic-Conic Seizure	Status
Jobst et al,[12] 2000	Adult, 14	na	28.6%	21.4%	64%	57%	36%	100%	na	93%	na
Boesebeck et al,[6] 2002	Adult, 42	na	28.6	26.2	33%	na	na	78.6	na	80.1	na
Ibrahim et al,[4] 2011	Ped, 41	na	27%		22%	na	na	na	14%	5%	na
Liava et al,[3] 2013	Ped, 62	63%	17.8%	11.3%	25.8%	54.8%	30.6%	73%	26%	18%	11%
Ramantani et al,[5] 2017	Ped, 50	74%	na	na	na	na	na	na	na	56%	10%
Francione et al,[2] 2019	Mixed 208, Ped & Adult	51%	30.8%		53.8%	46.7%	46.7%	na	4.8%	30%	9%
Sierra-Marcos et al,[11] 2017	Ped 55	63,6	32.2%		21.8%	49.1%	na	na	14.5%	18.2%	na
Craciun et al,[7] 2018	Ped 20	Na	20%	25%	na	30%	20%	na	40%	20%	na

In all studies visual auras as the hallmark phenomenon are seen in less than 50% of patients and in the adult series nonvisual auras, such as vertigo or epigastric are more common than visual auras of any kind. Temporal and frontal type refer to seizures that would clinically be classified as having typical frontal or temporal semiology. Please note that Jobst et al., and Craciun et al., report primary occipital lobe only, whereas the other studies report posterior cortex epilepsies. Also note that there is some overlap in patients between Liava et al and Francione et al.
Abbreviation: na, information not available.

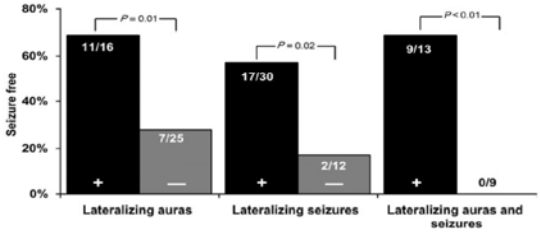
Jacobs et al. 2020.

Lateralizing semiology in posterior cortex epilepsy

semiology

- contralateral somatosensory and visual auras
- contralateral tonic, clonic or nystagmoid eye deviation
- contralateral tonic, clonic, versive seizures

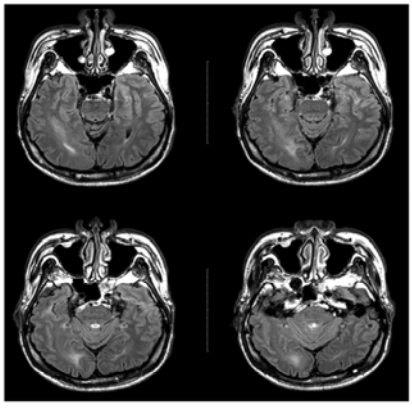
Lateralizing aura/seizure → good outcome

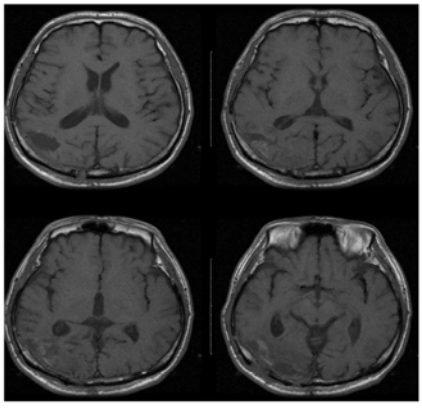


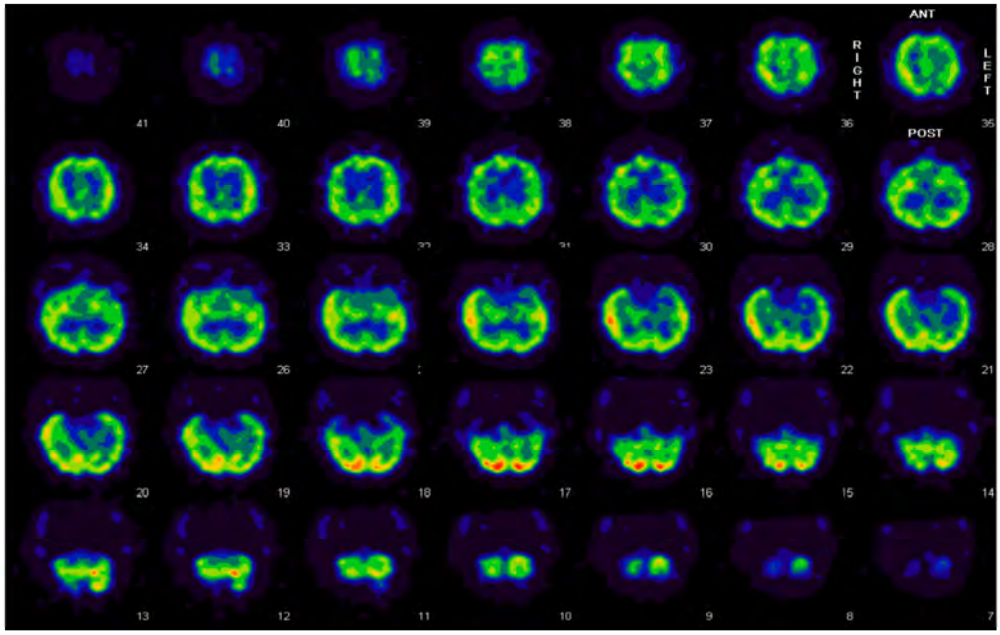
Boesebeck et al. 2002.

Occipital lobe epilespy

FCD at Rt. occipital area






ANT
RIGHT
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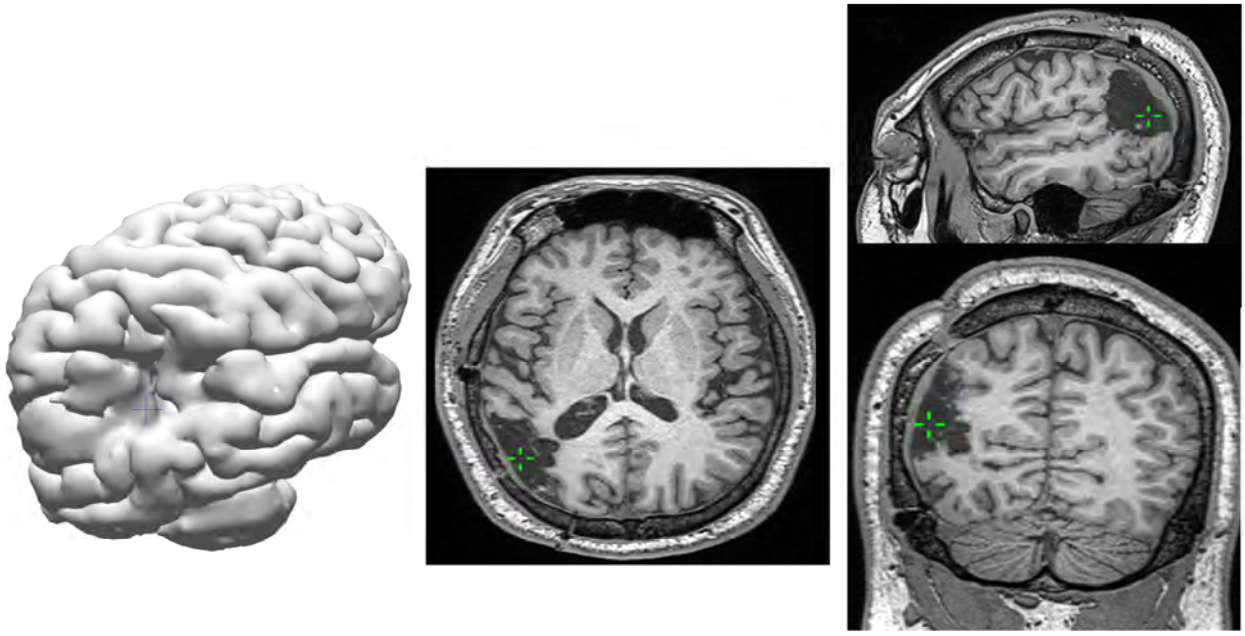
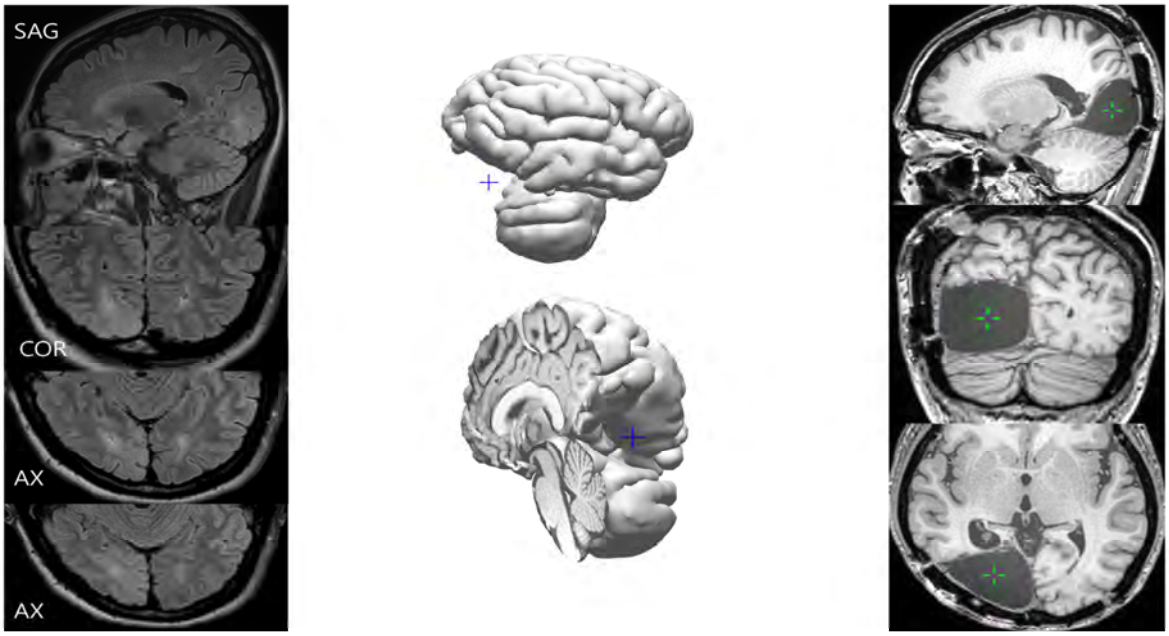
POST
41 40 39 38 37 36 35
34 33 30 29 28
27 26 23 22 21
20 19 18 17 16 15 14
13 12 11 10 9 8 7




SAG
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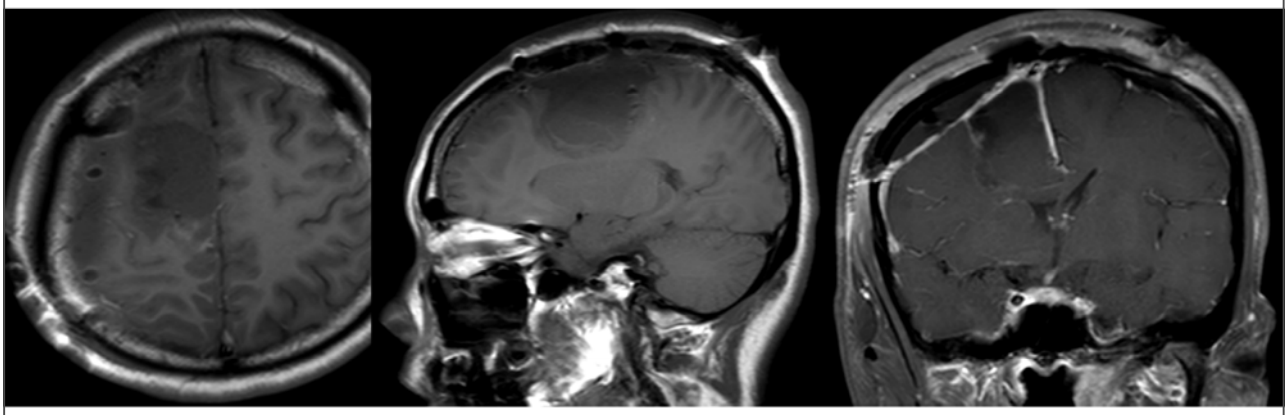

Conclusion

- Temporal lobe epilepsy
- Frontal lobe epilepsy
- Posterior cortex epilepsy