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ORIGINAL ARTICLE / KLİNİK ÇALIŞMA

Semiology, Video-Electroencephalography Monitoring, Neuroimaging, and Neuropsychological Functions in Lateralization/Localization in Extratemporal Lobe Epilepsies

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Ekstratemporal Lob Epilepsilerinde Lateralizasyon/Lokalizasyonda Semiyoloji, Video-Elektroensefalografi Monitorizasyonu, Nörogörüntüleme ve Nöropsikolojik Fonksiyonlar

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Summary

Objectives: The present study aimed to determine the semiological signs having high lateralizing/localizing value of epileptogenic area (EA) using video-electroencephalography monitoring (VEM), neuroimaging, and neuropsychological tests in patients with extratemporal lobe epilepsy (ETLE) and to investigate the correlation between these methods.

Methods: We enrolled patients who were admitted to the VEM unit between October 2006 and June 2012 due to ETLE. In total, 198 seizures of 34 patients, who were monitored for 24–120 h, were evaluated in detail by two observers. In accordance with the epilepsy protocol, all patients underwent cranial magnetic resonance imaging for anatomic localization and F-18-fluorodeoxyglucose positron emission tomography for functional localization due to drug-resistant epilepsy. Neuropsychological tests were performed by an experienced psychologist for frontal and parietal lobe localizations.

Results: The lateralization of EA using semiological signs could be performed in 67.6% of the patients. The signs having the highest lateralizing value were version, unilateral tonic activity, and unilateral clonic activity and those having the lowest lateralizing value were unilateral dystonia, unilateral smiling, unilateral automatism, and sensorial aura. Correlation analysis between anatomical functional foci determined by semiological signs and the results of ictal/interictal electroencephalography (EEG), neuroimaging, and neuropsychological tests could not be performed due to inadequate patient number. Nevertheless, only three patients (8.82%) having the same EA were detected by both semiological signs and other methods.

Conclusion: Our results suggest that the identification of epileptogenic focus in ETLEs is difficult despite multidisciplinary methods. We concluded that the most supportive diagnostic methods in identifying EA were interictal/ictal EEG, neuroimaging, and neuropsychological evaluation.

Keywords: Extratemporal lobe epilepsy; lateralizing/localizing signs; multidisciplinary approach; video-electroencephalography monitoring.

Özet

Amaç: Ekstratemporal lob epilepsi (ETLE) hastalarında epileptojenik alanı (EA) ortaya koymak amacıyla yüksek düzeyde lateralize/lokalize edici değere sahip semiyolojik bulguları belirlemek için Video-Elektroensefalografi Monitorizasyon (VEM), nörogörüntüleme, nöropsikolojik testler uygulanarak aralarındaki korelasyonu araştırmak hedeflenmiştir.

Gereç ve Yöntem: ETLE nedeniyle 2006–2012 yılları arasında VEM ünitesine yatırılan hastalar çalışmaya dahil edildi. 24–120 saat süre ile monitorize edilen 34 hastanın toplam 198 nöbeti iki gözlemci tarafından değerlendirildi. Hastalara epilepsi protokolüne göre anatomik lokalizasyon için kranial MRG, dirençli epilepsileri nedeni ile fonksiyonel lokalizasyon için PET-FDG çekimi yapıldı. Uzman psikolog tarafından frontal ve pariyetal lob lokalizasyonu için nöropsikolojik testler uygulandı.

Bulgular: Semiyolojik bulgular ile EA lateralizasyonu hastaların %67.6'sında yapılabildi. Lateralize edici değeri en yüksek olan bulgular; versiyon, tek taraflı tonik ak-tivite ve klonik aktivite; en düşük olan bulgular ise tek taraflı distoni, gülümseme ve otomatizma ve duyusal auralar olarak saptandı. Semiy-olojik bulgular ve anatomik-fonksiyonel odak ile iktal/interiktal EEG, nörogörüntüleme ve nöropsikolojik test sonuçları arasında hasta sayısı yetersiz olduğundan korelasyon analizi yapılamadı. Semiyolojik nöbet sınıflamasına göre saptanan EA ile diğer yöntemlerin saptadığı EA'nın birebir aynı olan sadece 3 hasta vardı.

Sonuç: Ekstratemporal lob epilepside epileptojenik odağı ortaya koymanın multidispliner yöntemlere rağmen zor olduğu görüşünü destekler nitelikteydi. EA ortaya koymada en çok destekleyici olabilen tanı yöntemlerinin sırasıyla interiktal/iktal EEG, nörogörüntüleme ve nöropsikolojik değerlendirme olduğu kanısına varıldı.

Anahtar sözcükler: Ekstratemporal lob epilepsisi; lateralizan/lokalizan bulgular; multidisipliner yaklaşım; video-EEG monitorizasyon.

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Introduction

Knowing the type of seizure and epilepsy is of great importance for identifying the diagnosis, treatment, and prognosis of patients with epilepsy. Seizure semiology forms the basis in the clinical identification of patients with epilepsy. Valuable lateralization results can be obtained via seizure semiology, and thus, the epileptogenic area (EA) can be successfully determined and successful surgical outcomes can be obtained without the need for invasive examination.[1]

Recently, advanced video-electroencephalography (EEG) monitoring (VEM) allows detailed analysis of semiologic al features of seizures that are correlated with simultaneous EEG activity.[2] VEM can detect many symptoms such as head and eye deviations, clonic convulsions, tonic convulsions, hypermotor movements, unilateral eye blinking, nystagmus, and ictal aphasia. Semiology together with EEG has gained value in determining the type and origin of seizure. It has been reported that certain semiologic al features of seizures give important hints in detecting hemispheric lateralization and lobar localization of seizures.[3]

Some semiological signs, which are called as lateralizing signs and help in predicting the hemisphere from which seizure arises, have been reported in the studies that have primarily taken temporal lobe epilepsy (TLE) or different partial epilepsies including TLE as the basis.[4,5] Determination of epileptic focus is much more difficult in extratemporal lobe epilepsies (ETLE) than in temporal lobe epilepsies. The use of a single method in determining focal epileptic focus can be deceptive. The precise detection of EA requires a multidisciplinary approach, which should include, at least, neuroimaging and neuropsychological evaluation in addition to semiological information obtained during VEM.[6,7] In the light of this information, the present study aimed to detect EA using semiological information, as well as VEM, neuroimaging, and neuropsychological evaluation in patients with ETLE and to investigate any correlation between these methods.

Materials and Methods

Patients

Patients aged ≥18 years who were hospitalized for ETLE in the VEM Unit of Department of Neurology, Uludağ University Medical Faculty between October 2006 and June 2012 were enrolled. Patients informations were retrospectively evaluated from the medical records. Patients with mental retardation were excluded. In total, 198 seizures of 34 patients were retrospectively and prospectively evaluated, and semiological signs were recorded. Neuroimaging [magnetic resonance imaging (MRI), positron emission tomography (PET)] and neuropsychological tests (NPTs) were performed on patients in whom seizures were observed in the VEM unit, and the ictal/interictal EEG recordings were reviewed. In addition to demographic characteristics of the patients such as age, sex, and dominant hand, clinical information and medical history such as age at the onset of epilepsy, duration of epilepsy, and response to antiepileptic therapy were recorded. Moreover, neuroimaging and NPT results and ictal/interictal EEG and semiological signs in the VEM unit were recorded. Approval of the university ethics committee was obtained for the study, and informed consents of all patients were obtained during hospitalization.

Video-electroencephalography monitoring

Epileptic therapies of the patients were discontinued by gradually decreasing the dosage 3 days before monitoring. Superficial scalp electrodes for VEM were placed in accordance with the international 10–20 system. All patients were monitored for 24–120 h.

GRASS-Telefactor Beehive Millennium (West Warwick, RI, USA) and Nicolet One VIASYS(CareFusion Corp., San Diego, CA, USA) long-term epilepsy monitoring systems were used for VEM. Video recording was performed continuously using a closed-circuit television system, whereas evaluation and analysis were performed using GRASS-Telefactor/Nicolet reading station and TWin EEG/NicVue long-term monitoring software (CareFusion Corp., San Diego, CA, USA).

The recording of seizures during VEM was performed by two observers as minimum two and maximum 20 seizures per patient and semiological signs having high lateralizing/localizing value were determined, and also the most possible EA was determined was ictal EEG findings.

In this study, the interictal changes were primarily classified into two main groups: epileptiform activity [sharp wave activity (+)/ spike-wave activity (+)/slow wave activity (+)/multiple spike-wave activity (+)] and non-epileptiform activity [dysrhythmia (+), paroxysm (+)]. There after, epileptiform and non-epileptiform activities in the interictal changes were classified into subgroups as focal, lateralized, and

generalized activities. The ictal changes were also classified as focal, lateralized, and generalized subgroups. There was also a muscle artefact group.

MRI protocol

MRI was performed using 1.5 T device (Magnetom Vision Plus, Siemens, Erlangen, Germany) and a standard head coil in accordance with the epilepsy protocol. MR images were displayed using axial, coronal, and sagittal planes at 1.5-mm section thickness. In addition to T1- and T2-weighted sections, FLAIR sequences were also obtained.

F-18-fluorodeoxyglucose positron emission tomography/computerized tomography (FDG-PET/CT) imaging

FDG-PET imaging was performed using Biograph 6 PET/CT Scanner (Siemens, Erlangen, Germany), and routine FDG-PET/CT imaging protocol was performed in all patients. PET images with or without attenuation correction, multiplanar PET, CT, and FDG-PET/CT fusion sections, and PET images of maximum intensity projection were examined on an LCD monitor using computer software (PET, SyngoMI, Siemens, Erlangen, Germany). The extratemporal lobes were visually evaluated on FDG-PET/CT.

Neuropsychological evaluation

In this study, a psychologist performed tests on all patients for approximately 2 h using psychometric devices that were sensitive to the relation of brain damage with mental changes and examined the relevant brain areas. NPTs included the Wechsler Memory Scale (WMS) mental control subtests, mental fluency test, planning test (clock drawing test), visuospatial skills test, the Stroop test, the Raven's standard progressive matrices (RSPM) test, the Benton facial recognition test, and the Benton judgment of line orientation test.

Frontal dysfunction was determined by evaluating WMS, mental fluency test, Stroop test, RSPM, and planning test altogether. In addition, parietal dysfunction was determined based on the evaluation of visuospatial skills test, the Benton facial recognition test, and the Benton judgment of line orientation test. Evaluation was performed in four categories: 1 = normal, 2 = mild impairment, 3 = moderate impairment, and 4 = severe impairment.

Statistical analysis

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA) version 13.0. Continuous variables were expressed as mean and standard deviation or median, minimum and maximum values, whereas categorical variables were expressed as number (n) and percentage (%). The comparison of two independent groups was performed using Mann–Whitney U test. A p-value of <0.05 was considered statistically significant.

Results

Of the 34 patients enrolled in the study, 19 (55.9%) were male and 15 (44.1%) were female; the mean age was 30.79±6.99 (range, 18–47) years. The mean age of the patients at the onset of seizures was 13.26±7.33 years, and the duration of epilepsy was 17.52±9.45 years. The rate of right hand dominance was 94.1%. While 29.4% of the patients were unresponsive to medical treatment, 70.6% had partial response. The patients were monitored in the VEM unit for 1–5 days (median, 5 days). The mean number of seizures over the course of monitoring period was 5.82±4.37. The features of the seizures are demonstrated in Table 1.

Of the seizures, 33.8% were secondary generalized. Since generalization was more common in the seizures arising

Table 1. Features of seizures

Features	Patients (n=34)		Seizures (n=198)	
	n	%	n	%
At sleep	27	79.4	113	57.1
Awake	27	79.4	85	42.9
Duration of seizure ≤1 min	25	73.5	159	80.3
Duration of seizure >1 min	10	29.4	39	19.7
Seizure at night+morning (between 0:00 and 12:00 am)	29	85.3	124	62.0
Seizure at noon+night (between 12:00 and 0:00 pm)	28	82.4	74	37.0
Status of being secondary generalized	17	50.0	67	33.8

Table 2. Semiological features of the study patients

Semiological features	Patients (n=34)		Seizures (n=198)	
	n	%	n	%
Preictal				
Feeling of a seizure coming on (an indescribable feeling)	10	29.4	28	14.1
Autonomic aura	9	26.5	42	21.2
Sensorial aura	3	8.8	11	5.5
Aura of pain	3	8.8	9	4.5
Ictal				
Version (total)	18	52.9	61	31.3
Hypermotor movements	17	50.0	59	29.8
Vocalization (non-verbal)	16	47.1	49	24.7
Unilateral tonic (arm/leg)*	16	47.1	57	28.8
Scared facial expression	15	44.1	53	26.8
Ictal apathy	14	41.2	56	28.3
Contralateral version (late)	12	35.3	31	15.6
Contralateral tonic (arm/leg)*	10	29.4	35	17.7
Dystonic posture (arm/leg)	10	29.4	57	28.8
Aphasia	10	29.4	68	34.3
Ictal autonomy (hyperventilation)	9	26.5	26	13.1
Unilateral clonus (face, arm/leg)	8	23.5	22	11.1
Contralateral clonus (face, arm/leg)	8	23.5	22	11.1
Tonic convulsions in four extremities	7	20.6	24	12.1
Ipsilateral version (early)	6	17.6	30	15.2
Eye deviation alone (late)	6	17.6	27	13.6
Bilateral eye blinking	6	17.6	8	4.0
Verbalization	6	17.6	29	14.6
Ictal sense of suffocation	4	11.8	23	11.6
Startle	4	11.8	26	13.1
Contralateral dystonia (arm/leg)	4	11.8	25	12.6
Head nod (forward-backward)	4	11.8	13	6.6
Figure 4 sign	3	8.8	8	4.0
Ictal vomiting	3	8.8	12	6.1
Unilateral eye blinking	2	5.9	5	2.5
Grimacing	2	5.9	11	5.6
Vertigo	2	5.9	13	6.6
Unilateral smiling	1	2.9	2	1.0
Nystagmus	1	2.9	20	10.1
Ictal pain	1	2.9	2	1.0
Ictal urinary urgency	1	2.9	4	2.0
Oroalimentary automatism	8	23.5	14	7.1
Unilateral automatism (ipsilateral)	7	20.6	16	8.1
Gesture automatism (clapping hands)	3	8.8	6	3.0
Automatism in hands	3	8.8	7	3.5
Ictal genital automatism	1	2.9	3	1.5
Postictal				
Postictal immediate cooperation and orientation	22	64.7	126	63.6
Postictal disorientation	21	61.8	72	36.4
Postictal nose wiping (ipsilateral)	9	26.5	12	6.1
Postictal wheezing	3	8.8	6	3.0
Postictal coughing	3	8.8	5	2.5
Postictal crying	2	5.9	7	3.5
Asymmetric ending of convulsion	1	2.9	4	2.0
Postictal paresis	–	–		
Postictal laughing	1	2.9	4	2.0

*The reason for less common contralateral tonic seizure than unilateral tonic seizure is the presence of tonic convulsions also in the patients having no lesion.

Table 3. Neuroimaging findings

Magnetic resonance imaging findings	n	%	Positron emission tomography findings	n	%
No lesion	16	47.1	Normal activity	11	32.4
Frontal			Right frontal	3	8.8
Dorsolateral	5	14.7	Left frontal	2	5.9
Motor area	6	17.6	Bifrontal	1	2.9
Ventromedial	4	11.8	Right frontotemporal	1	2.9
Premotor	4	11.8	Right parietal	1	2.9
Parietal			Left parietal	2	5.9
Postcentral	4	11.8	Right frontoparietal	1	2.9
Inferior parietal gyrus	2	5.9	Left frontoparietal	1	2.9
Superior parietal gyrus	1	2.9	Right temporoparietal	1	2.9
Frontooccipital	1	2.9	Right parietooccipital	1	2.9
Temporooccipital	1	2.9	Left temporoparietooccipital	1	2.9
Temporoparietal	1	2.9	Right temporal	3	8.8
			Left temporal	2	5.9
			Bilateral temporal	3	8.8

A large lesion detected on the MR imaging of a patient was included in two groups (e.g., a frontoparietal lesion was included in both parietal and frontal signs).

from the premotor and precentral areas, we compared the secondary generalized seizures within themselves. Semiologic al classification was made according to the functional properties of the premotor and precentral regions. While the number of median generalized seizures was 0.00 (range, 0–4) excluding the premotor/precentral seizures, it was found to be 1.50 (range, 0–24) in the group having premotor/precentral seizures. No significant difference was determined between the two groups in terms of progression to secondary generalization (p=0.164). The semiological features of the patients are demonstrated in Table 2.

Aura, which was defined by the patients as a feeling of a before seizure coming on, was determined in 10 patients, of whom five had lesions in the frontal lobe, three had lesions in the parietal lobe, and two were lesion-free. Sensorial aura was determined in three patients, of whom two had lesions in the parietal lobe and one had lesion in the frontal lobe. These sensorial auras pointed out the contralateral hemisphere in all these three patients. The lesions were in the dorsolateral and ventromedial aspects in all of the three patients with aura of pain.

The first five leading lateralizing/localizing ictal/postictal semiological signs were postictal immediate cooperation and orientation (64.7%), postictal disorientation (61.8%), versive deviation (52.9%), hypermotor movements (50.0%), unilateral tonic convulsion (47.1%) and vocalization (nonverbal) (47.1%). The least common signs were genital automatism, ictal smiling, ictal urinary urgency, ictal pain, asymmetric ending of seizure, nystagmus, postictal smiling (2.9% for each), vertigo, postictal crying, grimacing, unilateral eye blinking (5.9% for each), four sign, ictal vom-iting, bilateral automatism in hands, gesture automatism, postictal wheezing, and coughing (8.8% for each).

Evaluation of localizing/lateralizing ictal/postictal semiological signs according to the number of seizures revealed that

Table 4. Electroencephalography findings of the study patients

	n	%
Ictal		
Left focal epileptiform activity	11	32.3
Right focal epileptiform activity	7	20.6
Left lateralized epileptiform activity	2	5.9
Right lateralized epileptiform activity	2	5.9
Generalized epileptiform activity	8	23.5
Muscle artefact	4	11.8
Interictal		
Left focal epileptiform activity	6	17.6
Right focal epileptiform activity	8	23.5
Left lateralized epileptiform activity	3	8.8
Generalized epileptiform activity	1	2.9
Left focal non-epileptiform activity	4	11.8
Right focal non-epileptiform activity	2	5.9
Left lateralized non-epileptiform activity	2	5.9
Normal	8	23.5

Table 5. Results of neuropsychological tests of the study patients

	Normal		Mildly impaired		Moderately impaired		Severely impaired	
	n	%	n	%	n	%	n	%
WMS mental control subtests	10	29.4	11	32.4	8	23.5	–	–
Mental fluency test	23	67.6	2	5.9	2	5.9	2	5.9
Planning test	27	79.4	1	2.9	–	–	1	2.9
Visuospatial skills test	25	73.5	1	2.9	2	5.9	1	2.9
RSPM test	19	55.9	5	14.7	2	5.9	1	2.9
Stroop test	19	55.9	7	20.6	1	2.9	–	–
Benton facial recognition test	28	82.4	–	–	–	–	–	–
Benton judgment of line orientation test	26	76.5	1	2.9	–	–	–	–

WMS: Wechsler Memory Scale; RSPM: Raven's standard progressive matrices. *Some patients could not be evaluated as they failed to comply with some of the tests.

postictal immediate cooperation and orientation (63.6%), postictal disorientation (36.4%), ictal aphasia (34.3%), versive deviation (31.3%), hypermotor movements (29.8%), unilateral tonic convulsion and dystonia (28.8%) were the most commonly encountered signs. The least common signs were unilateral smiling, ictal pain (1.0% for each), and genital automatism (1.5%).

Table 6. Functional-anatomic classification of seizures according to semiological signs obtained by video-electroencephalography monitoring

Classification	n	%
Dorsolateral	6	17.6
Ventromedial	3	8.8
Premotor	2	5.9
Premotor+dorsolateral	5	14.7
Dorsolateral+ventromedial	4	11.8
Premotor+motor	2	5.9
Motor+dorsolateral	2	5.9
Premotor+ventromedial	2	5.8
Motor+ventromedial	1	2.9
Parietal+ventromedial	1	2.9
Dorsolateral+ventromedial+premotor	3	8.7
Dorsolateral+ventromedial+parietal	1	2.9
occipital+dorsolateral+parietal	1	2.9
Premotor+dorsolateral+ventromedial+ parietal	1	2.9

Neuroimaging findings are demonstrated in Table 3. While no lesion was detected on MRI in 47.1% of the patients, there were 20 frontal lobe, eight parietal lobe, two occipital lobe, and two temporal lobe lesions. PET-FDG activity was found normal in 32.4% of the patients. Pure frontal hypometabolism was determined in six patients, pure parietal hypometabolism was determined in three patients, and pure temporal hypometabolism was determined in eight patients; two or three foci were determined in the remaining patients.

Ictal EEG demonstrated focal epileptiform activity in 18 patients, lateralized epileptiform activity in four patients, and generalized epileptiform activity in eight patients. Interictal EEG revealed normal activity in eight patients, whereas 18 patients showed epileptiform activity and eight showed non-epileptiform activity. EEG findings of the patients are summarized in Table 4.

The highest number of patients with dysfunction was observed by WMS (n=19), followed by RSPM (n=8), and Stroop test (n=8). The Benton facial recognition test revealed no impairment in any of the patients (Table 5).

Table 7. Encounter of PET/MR/Interictal EEG findings in 30 patients who had frontal seizures semiological signs

	Normal	Frontal	Frontoparietal	Frontotemporal
Positron emission tomography findings	11	6	2	1
Magnetic resonance findings	16	7	–	–
Interictal electroencephalography findings	–	6	–	8

PET: Positron emission tomography; MR: Magnetic resonance; EEG: Electroencephalography.

Semiological classification of seizure types revealed that dorsolateral seizure (17.6%) was most commonly encountered. Functional anatomic classification of seizures according to the semiological signs obtained by VEM (onset-spread-ending of seizure) is demonstrated in Table 6.

Discussion

The semiological signs of ETLE have a wide spectrum based on the site of origin.[8] Although semiological signs do not always detect the epileptic focus, they provide many hints for diagnosis.[9,10]

During ETLE seizures, various levels of unconsciousness and communication are possible.[11] In our study, the most common lateralizing sign (63.6%) was postictal immediate cooperation and orientation. Postictal disorientation was observed in 36.4% of the seizures. Immediate cooperation is associated with sudden onset and ending of frontal seizures. The high rates of disorientation in our study could be attributed to the spread of electrical activity over the temporal lobe. Disorientation has been reported to be more frequent after right temporal seizures.[6]

Ictal aphasia is encountered only in conscious patients and is associated with electrical activity in the dominant hemisphere.[12] In our study, ictal aphasia was the third most com-mon semiological sign. Verbalization and vocalization are moderately common semiological signs in ETLE. Koerner and Laxer's[13] study observed ictal verbalization in 13/84 pa-tients with focal epilepsy and considered that this situation was associated with the dominant hemisphere. Janszky et al.[14] detected ictal vocalization in 11/27 patients with frontal lobe epilepsy and determined left (dominant) frontal lobe epilepsy in nine patients. Fried[15] expressed that ictal vocalization had no localization/lateralization value. In this study, the rates of ictal vocalization and verbalization during seizures were 24.7% and 14.6%, respectively. While the dominant hemispheric lateralizing value of vocalization was 8.33%, the lateralizing value of verbalization could not be detected since all patients with verbalization were non-lesional.

The frequency of ictal nystagmus has been reported between 0.5% and 18% in patients with epilepsy.[16,17] In our study, ictal nystagmus was observed in only one patient (right-handed, with left-hemispheric lesion) and in his/her all seizures.

Motor symptoms are among the most prevalent lateralizing symptoms in frontal lobe seizures.[18] Hypermotor movements, the characteristic of frontal lobe seizures, may be rarely seen even in TLEs.[19] In this study, unilateral tonic activity was showed that lateralized contralateral in 10 patients and ipsilateral in six patients. Eight patients had unilateral clonic activity, and it was showed lateralizing to the contralateral in all.

Kernan et al.[20] determined that forced head deviation in 92 secondary generalized tonic–clonic seizures in 29 patients with lateralized epileptic foci indicated contralateral hemisphere in >90% of the seizures which occurred during generalized tonic–clonic seizure and 10 s before generalization. Chee et al.[21] investigated versive lateralization in 38 patients with frontal and temporal lobe epilepsies, observed version in 45%, and found the positive predictive value as 94%. In this study, version was observed in 18 patients, lateralizing to the contralateral (n=12) and ipsilateral (n=6) hemispheres.

Figure 4 sign was first defined by Bleasel et al.[22] (1994). In a study evaluating 238 seizures of 34 TLE and 20 ETLE cases with a history of secondary generalized seizure, the rate of Figure 4 sign was 78.6% and 53.3% in the TLE and ETLE cases, respectively, and contralateral lateralizing values of this sign were 90.9% and 87.5%, respectively. In this study, Figure 4 sign was detected in three patients; extensor extremity indicated the contralateral in all three of them.

Somatosensorial, autonomous, emotional, and cognitive auras can be seen in frontal lobe seizures. These auras are less common and have generally no lateralization value. However, Mauguiere F, Courjon[23] reported struc-tural lesion in 92 and focus on EEG in 32/127 cases with somatosensorial aura. The most commonly involved areas were upper extremities, hands, and face, and auras indicated EA to be contralateral. Tuxhorn[24] detected sensorial aura in 12% of 600 patients with focal epilepsy, of whom EA was contralateral in 46% and ipsilateral in 6% and no lateralization was observed in 25%. In this study, aura of pain and sensorial aura lateralizing to the ipsilateral were determined in three patients each.

Bonelli et al.[4] (2007) reported likely detection of epileptic focus by semiological signs in 81% of the patients in frontal lobe seizures. While unilateral clonic activity, unilateral grimacing,

and version are considered to be signs with high lateralizing value in patients with ETLE, four sign, unilateral automatism in the hand, early head deviation, unilateral eye blinking, and postictal nose wiping have low lateralizing value.[18,25] In this study, EA lateralization by semiological signs was performed in 23 (67.6%) patients. Hypermotor activity was the most common semiological sign in the patients, in whom lateralization could not be performed (n=11). The signs with the highest lateralizing value were version and unilateral tonic and clonic activities, whereas those with the lowest lateralizing value were unilateral dystonia, unilateral smiling, unilateral automatism, and sensorial aura.

Seizure semiology is an important factor in determining EA, and its consistency with ictal/interictal EEG and neuroimaging findings contributes to the reliability of this determination.[26,27] However, in our study, correlation analysis between semiological signs and neuroimaging findings could not be performed because of the high number of parameters and low number of patients.

In frontal lobe epilepsies, interictal and ictal EEGs may not give adequate information on lateralization/localization because of difficulty in evaluating large frontal lobe areas via superficial EEG and extensive connections in the frontal lobes causing rapid spread of epileptic discharges.[28] In this study, the focus detected in 18 patients with focal epileptiform activity on ictal EEG; fourteen had frontal focus, the remaining three had temporooccipital focus and one had temporal focus. While the localization of semiological sign was frontooccipital lobe in only one of these four patients, it was frontal lobe in others. Accordingly, these four patients possibly had false-localizing focal sign; however, this might be inconvenient since the exact focus was not detected by surgery.

Interictal EEG supports diagnosis. Ten patients had the same localization on ictal and interictal EEG. While four patients had the same localization on ictal EEG, interictal EEG, and MRI, equal number of patients (n=7) had the same localization on both ictal EEG-MRI and interictal EEG-MRI. MRI, the most important examination method particularly for patients with epilepsy and partial seizures, significantly contributes to localization and detects lesions suitable for surgical resection in 60% of patients undergoing frontal lobe surgery. Although concordance between EEG and MRI is close to 90% in TLEs, it is lower in ETLEs.[29]

Anomaly can be demonstrated by initial MRI in 50%–67% of patients with frontal lobe epilepsy. The rate of not demonstrating lesion by fine-section and high-tesla MRI is about 20%.[30] Detection of exact localization in patients with non-lesional ETLE is difficult. In this study, lesion could not be detected on MRI in 16 (47.1%) patients, of whom localization by semiological signs was dorsolateral in nine, premotor area in seven, motor area in one, and ventromedial area in five. Localization by semiological signs may indicate several concurrent foci in a patient due to electrical spread. We determined two foci in six and three foci in two patients. Localization by semiological signs in three of 16 patients indicated common foci with ictal/interictal EEG, FDG-PET, and NPTs. FDG-PET activity was normal in eight of 16 patients with normal MRI.

In this study, while PET activity was normal in 32.4% of the patients, hypometabolism was determined in different foci in 67.6%. FDG-PET activity revealed only frontal hypometabolism in six patients with semiological sign of frontal lobe. FDG uptake indicated frontal, parietal, and temporal focus in one of each three patients with semiological signs of parietal + frontal lobes. FDG-PET demonstrated temporal focus in the patient having semiological signs of occipital + frontal + parietal lobes. FDG-PET activity indicated temporal focus in seven (20.6%) patients with semiological signs of extratemporal lobe. In a study evaluating 15 patients with ETLE, 86.6% of NPTs and 73% of PETs were abnormal. These 15 patients' dysfunction in the localization/lateralization areas determined by NPTs and PET were similar by 85% to those determined electronically.[31]

Exposing cognitive profile and determining deficits via NPTs are quite difficult in frontal lobe epilepsies. Although NPTs have an important role in preoperative evaluation, its reliability in lateralization/localization has not been exactly verified. Rausch[32] stated that interpretation of patient's test profile by an experienced neuropsychologist rather than by test scores is a guide in seizure lateralization by NPTs. In this study, of the 34 patients having frontal and/or parietal epileptogenic focus by semiological signs, eight had impaired frontoparietal tests and 13 had impaired frontal tests in NPTs performed by a psychologist. There were eight patients with normal test results. In the patients having frontal and parietal semiological signs, the relevant dysfunction was best detected by WMS, followed by RSPM and Stroop test.

The major limitations of this study are the lack of surgical intervention and limited patient number. ETLE diagnosis was made based on characteristics of the seizure and ictal activity on EEG. Furthermore, we excluded all the patients with unclear diagnosis, which is the reason of our low number of patients. We excluded mentally retarded patients from our study group because it can be difficult to record the aura and symptoms derived from extra temporal area in mentally retarded patients.

Only three patients (8.82%) had the same EA detected by both semiological signs and other methods. This result supports the opinion that exposing epileptogenic focus in patients with ETLE is difficult despite multidisciplinary methods.

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