Solitary epileptic seizures in the clinical practice

Part II: Findings of various modifications of EEG examination and imaging methods in patients who experienced solitary unprovoked epileptic seizure

Branislav Kollar [1], Zuzana Martiniskova [1], Katarína Klobucnikova [1], Ivana Vachalova [1], Iveta Waczulikova [2]

[1] 1st Department of Neurology, Faculty of Medicine, Comenius University, Bratislava
[2] Division of Biomedical Physics, Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava; Slovak Republic.

Correspondence to: Branislav Kollár, M.D., Ph.D.
1st Department of Neurology, Faculty of Medicine,
Comenius University, Bratislava, Slovak republic
PHONE: +421 257 290 147; E-MAIL: b.kollar@pobox.sk, cyklobrano@gmail.com

Submitted: 2009-06-11 Accepted: 2009-07-28 Published online: 2009-09-15

Key words: **solitary unprovoked epileptic seizure; EEG; CT; MRI**

Neuroendocrinol Lett 2009; **30**(4): 487–490 **PMID:** 20010487 NEL300409A10

Abstract

BACKGROUND: The occurrence of the first unprovoked epileptic seizure always requires thorough examination. The risk of incorrect diagnosis is high, non-epileptic seizures represent 20–33% of newly diagnosed cases. The aim of the study is to evaluate findings of various modifications of EEG examination in the group of patients who experienced solitary unprovoked epileptic seizure and compare benefits of CT and MRI examination of the brain of these patients.

MATERIAL AND METHODS: The group involved 84 patients hospitalized at the 1st Department of Neurology , Faculty of Medicine, Comenius University in Bratislava between January 1997 and January 2007 after experiencing unprovoked epileptic seizure. It is a retrospective analysis of information from medical records and clinical documentation. For statistic comparing of benefits of various modifications of EEG examination and between CT and MRI examination of the brain binomic test of proportion was used.

RESULTS: Interictal epileptiform EEG graphoelements in native EEG was recorded only in 14.29% of patients. Statistically significantly more epileptiform graphoelements comparing EEG and EEG after sleep deprivation of the patient (SD) with one- hour recording was recorded with 24-hour 8 channels EEG monitoring after SD, EEG after SD with one- hour recording was of no significance comparing to native EEG. MRI examination of the brain was statistically more significant comparing to CT examination.

CONCLUSION: Low catchment of epileptiform EEG graphoelements in patients with solitary unprovoked seizure shows the importance of precise history in diagnostics of these patients. Though EEG is a very important examination it is an auxiliary one. We confirmed that MRI examination in patients who experienced solitary unprovoked epileptic seizure is undoubtedly the first choice method.

ORIGINAL ARTICLE

INTRODUCTION

Electroencephalography (EEG) is an important non-invasive examination method that informs about electrical activity of the brain. It plays an important role in differential diagnostics of seizures. The greatest diagnostic benefit of EEG belongs to diagnosis of epilepsy. Finding of interictal epileptiform graphoelements supports the diagnosis of epilepsy with specificity of 96% (Vojtěch, 2008; Zivin & Ajmone-Marsan, 1968). In patients who experienced the first unprovoked epileptic seizure 30–40% catchment of specific epileptiform EEG abnormalities after the first EEG examination was reported. (King *et al.* 1998; Shinnar *et al.* 1994). Higher catchment was reported in EEG realized within 24 hours from experienced seizure than after 24 hours (51% versus 34%) (King *et al.* 1998). Abnormal EEG occurs more frequently in patients with partial seizures than in patients with generalized seizures and in patients with late symptomatic etiology of epilepsy than in patients with idiopathic epilepsy (Shinnar *et al.* 1994).

Imaging examinations represent one of the basic methods in diagnostics of patients with epileptic seizures. Their development has significantly contributed to accurate diagnostics and classification of epileptic syndromes. It is necessary to realize that these methods can help reveal etiology of seizures and determine etiopathogenetic diagnosis. The fact that each patient after first epileptic seizure must undertake these examination is common and generally accepted.

MRI is an advantageous imaging method for CNS. At present this method is the first choice method. Comparing with CT contrast resolution is better. MRI has no problems with surrounding skeleton that caused artifacts in simpler CT. MRI examination has higher informative value in expressing structures of the nervous system (white and grey matter) than CT examination of the brain. It is the method of choice in examination of lesions of the back cerebral pit (fossa cerebralis posterior) and affections deposited close to middle line and on cranial basis. MRI can reveal structural lesions and brain anomalies which CT examination, that is less sensitive, cannot (heterotopias, demyelinizations, anomalies of gyrifications, vascular malformations, etc.) (Bořuta *et al.* 2007; Sýkora *et al.* 2008). MRI is markedly more advantageous in patients with temporal epilepsy where it is able to express even very tiny structural changes and mesial temporal sclerosis (Carrilho *et al.* 1994). In addition, in MRI examination patients are not exposed, in contrast to CT, to radiation load. CT advantages involve better availability, relatively low price, possibility to examine non-cooperating patients because the examination takes only several seconds and it is less sensitive to movable artifacts. Moreover, CT has less contraindications comparing to MRI. MRI cannot be realized in patients with metal implants and clips, pacemaker, uncontrollable claustrophobia. Result can be adulterated if the patient does not cooperate.

MATERIAL AND METHODS

The group consisted of 84 patients hospitalized at the 1st Department of Neurology, Faculty of Medicine, Comenius University in Bratislava between January 1997 and January 2007 after experiencing unprovoked epileptic seizure. We evaluated EEG findings and compared diagnostic benefit of native EEG examination, EEG examination after SD with one- hour recording with electrodes circuit in the system of 10 – 20 and 24- hour EEG eight-channel EEG examination after SD (LTM-EEG after SD). We evaluated and compared findings and diagnostic benefit of CT and MRI examination of the brain. Data were obtained by a retrospective analysis of information from medical records and clinical documentation. "Native" interictal EEG was recorded for 20 minutes on the hairy surface of the head with electrode circuit in the system of 10–20, in all cases also with realization of 4-minute hyperventilation (HV) by mouth in frequency of 30 inspirations and expirations per a minute and photostimulation (PS) by flashes of the neon lamp – used frequency of flashes was 4,8,10,12,14,24 Hz. The findings were assessed as normal and abnormal where abnormal findings were divided to epiletiform or non-epileptiform. Presence of spikes, sharp waves, spike and wave complexes, complexes of more spikes and a wave and complexes of a sharp and slow wave was evaluated as a specific epileptiform activity. Further abnormalities in EEG were assessed as non-epileptiform (non-specific). Abnormalities in EEG (epileptiform and non-epileptiform) were divided into regional (focal) and generalized (difuse, non-focal).

Activation with sleep deprivation and LTM-EEG after SD was realized only in a part of patients from the reason of:

- diagnostic confirmation of seizures of epileptic origin
- searching for focus in epileptic syndrome
- within the diagnostic process in unclear seizures

CT and MRI findings were assessed as normal and pathological. Pathological finding was any deviation from normal. In patients with realized both CT and MRI examinations of the brain we evaluated, in case of pathological finding on CT and MRI examinations, if MRI contributed to deeper specification of the pathological finding present on CT and if MRI examination was more beneficial in these patients. In patients with both imaging methods realized the diagnostic benefit was statistically compared.

For statistic comparing of benefits of various modifications of EEG examination and for comparing of diagnostic benefits between CT and MRI examination of the brain binomic test of proportion was used.

RESULTS

Table 1. Interictal EEG findings, EEG findings after SD and LTM-EEG after SD in patients who experienced solitary unprovoked epileptic seizure.

	Normal	NFA	NGA	EFA	EGA
EEG (n=84)	41 (48.81%)	23 (27.38%)	8 (9.52%)	8 (9.52%)	4 (4.77%)
EEG after SD (n_1=59)	35 (59.33%)	9 (15.25%)	6 (10.17%)	6 (10.17%)	3 (5.08%)
LTM-EEG after SD (n_2=46)	35 (76.09%)	6 (13.04%)	2 (4.35%)	2 (4.35%)	1 (2.17%)

(n = whole number of patients who underwent interictal EEG examination, n_1 = number of patients who underwent EEG after SD and n_2 = number of patients who underwent LTM-EEG after SD. The numbers of patients are not identical for in case of diagnosed epileptic disorder or epileptic focus the whole EEG diagnostic algorithm was not needed. NFA = non-epileptiform focal EEG abnormality, NGA = non-epileptiform generalized EEG abnormality, EFA = epileptiform focal EEG abnormality, EGA = epileptiform generalized EEG abnormality).

Statistical evaluation by binomic test of proportions Benefit of EEG after SD compared to native EEG: p=0.3228 – insignificant difference between proportions.

Benefit of LTM-EEG after SD compared to native EEG + EEG after SD with the time of recording one hour: p=0.0338 – significant difference between proportions.

In patients after solitary unprovoked epileptic seizure also findings of both the CT and MRI examinations of the brain were evaluated (Table 2). In patients with realized both CT and MRI examinations of the brain their diagnostic benefits were statistically compared. If pathological finding on CT and MRI was found and MRI enabled closer specification of the pathological CT finding, we considered only MRI examination of the brain as diagnostically beneficial (Table 3).

Statistical evaluation of benefits of MRI examination comparing to CT examination by binomic test of proportions: p<0.0001 – high significant difference between proportions.

Table 2. Findings of CT and MRI examinations of the brain in patients after solitary unprovoked epileptic seizure (n=84).

	UNPROVOKED SOLITARY EPILEPTIC SEIZURES	
	Number of patients	Number/whole (%)
CT brain	21	
Normal	5	23.81%
Pathology	16	76.19%
MRI brain	6	
Normal	2	0.33%
Pathology	4	0.67%
Realized CT and MRI	57	
CT normal MRI normal	28	49.12%
CT normal MRI pathol.	12	21.05%
CT pathol. MRI pathol./ closer specification CT by MRI examination	17/12	29.83%
CT pathol. MRI normal	0	0%

Table 3. Patients after solitary unprovoked epileptic seizure in which both imaging methods were realized (n=57).

	Benefit
CT of brain (n=57)	5 (8.77%)
MRI of brain (n=57)	29 (50.88%)

DISCUSSION

We found that catchment of epileptiform manifestations in native EEG in patients who experienced solitary unprovoked epileptic seizure (14.29%) is lower than reported in literature (King *et al.* 1998; Shinnar *et al.* 1994; Vojtěch, 2008; Zivin & Ajmone-Marsan, 1968). It might be explained by accepted fact of transient incidence of abnormalities in EEG records. That is the reason that transient incidence of epileptiform EEG abnormalities in patients with epilepsy is considered the factor participating on different results of particular studies. High percentage of non-specific (non-epileptiform) abnormal EEG records in our cohort of patients who experienced solitary epileptic seizure is in agreement with literature data (Klass & Daly, 1979).

As mentioned above EEG plays a very important role in differential diagnostics of paroxysmal disorders. Recording of specific epileptiform EEG graphoelements in correlation with history and clinical picture enables to confirm or support the diagnosis of epilepsy. It is known that occurrence of epileptic seizures and EEG epileptiform manifestations is usually accidental and that EEG characteristics varies fast. In effort to reduce the proportion of so called negative EEG findings (without epileptiform activity) in patients with epilepsy, more activating methods were included into clinical practice as hyperventilation, photostimulation, sleep deprivation (Nešpor, 2007). Long term monitoring EEG (LTM-EEG) is used to reveal some latent manifestations.

Our results showed that the difference in catchment of epileptiform EEG manifestations between interictal native EEG (using HV and PS) and EEG after SD recorded for the time of one hour in the group of patients who experienced solitary unprovoked epileptic seizure was statistically insignificant. On the contrary more statistically significant epileptiform findings were recorded by LTM-EEG after SD when compared to native EEG + EEG after SD with the time of recording of one hour. It is very important to realize the limits of EEG examination. Firstly – normal EEG finding does not rule out clinical diagnosis of epilepsy and presence of epileptiform EEG abnormality does not confirm that the patient has epilepsy. Recurrent occurrence of abnormal interictal EEG findings in the group of non-epileptic seizures is also known (Kuba *et al.* 2001; Kukumberg, 2007). That´s why EEG must be recognized as the method that plays a very important role in diagnostics of epilepsy or paroxysmal disorders, however, as the adjuvant examination method its role is limited. In clinically clear epileptic manifestations EEG can confirm, or in specific cases support, clinically clear diagnosis of epilepsy. In clinically absent typical epileptic manifestations high cautiousness is needed in evaluation of the diagnosis (incorrect evaluation or over-evaluation of EEG finding).

Recent development of imaging methods has significantly contributed to make diagnosis and classification of epileptic syndromes more precise. MRI is currently considered the first choice method in patients with epilepsy (Komárek, 2007). Our results in the group of patients who experienced solitary unprovoked epileptic seizure confirm this. CT scanning did not show any pathology which would not be shown by MRI examination. However, cases with normal CT finding and pathological MRI finding were observed repeatedly. Moreover, MRI examination of the brain enabled closer specification of the pathological process on CT in cases with abnormal CT finding. As far as the diagnostic benefits of MRI in our patients who experienced solitary unprovoked epileptic seizure are concerned, MRI examination of the brain brought benefit, comparing to CT examination, in 24 out of 57 cases with concurrently realized CT and MRI examinations and brought statistically significantly more diagnostic information when compared to CT examination ($p<0.0001$). These figures prove that CT has lower informative value when compared to MRI examination of the brain and thus it has to be indicated only in case when MRI cannot be used (medical contraindication or absence of the device) or in case of urgency (in risk of "delay" when acute brain damage id suspected).

CONCLUSION

Epileptiform graphoelements in native interictal EEG were recorded in 14.29% of patients who experienced solitary unprovoked epileptic seizure. Difference in catchment of epileptiform EEG manifestations between native interictal EEG examination and EEG after SD recorded for the time of one hour was statistically insignificant. On the contrary, statistically significantly more epileptiform EEG findings were recorded by 24-hour EEG after SD (LTM-EEG after SD) comparing to native EEG and EEG after SD recorded one hour. Here it must be emphasized that diagnosis of solitary epileptic seizure and epilepsy is clinical diagnosis. EEG is in this group of patients very important examination but still the adjuvant examination.

Statistical comparing of diagnostic benefits of CT and MRI examinations of the brain confirmed that MRI examination of the brain in patients who experienced solitary unprovoked epileptic seizure is definitely the first choice method.

ACKNOWLEDGEMENT

This work is partially supported by the Slovak Science Grant Agency (VEGA No 1/0755/09, VEGA No 1/4266/07).

REFERENCES

1 Bořuta P, Neuschl V, Glézlová A, Jánska P (2007). Úloha magnetickej rezonancie (MR) v diagnostike ochorení centrálneho nervového systému (CNS). [(The role of magnetic resonance imaging in the diagnosing of the central nervous diseases.) (In Slovak with English abstract.)]. Neurológia. **2**: 121–126.
2 Carrilho PG, Yacubian EM, Cukiert A, Fiore LA, Buchpiguel CA, Jorge CL, *et al.* (1994). MRI and brain spect findings in patients with unilateral temporal lobe epilepsy and normal CT scan. Arq Neuropsiqiatr. **52**: 149–52.
3 King MA, Newton MR, Jackson GD, Fitt GJ, Mitchell LA, Silvapulle MJ, *et al.* (1998). Epileptology of the first-seizure presentation: a clinical, electroencephalographic, and magnetic resonance imaging study of 300 consecutive patients. Lancet. **352**: 1007–1011.
4 Klass DW, Daly DD, editors (1979). Current Practice of Clinical electroencephalography. New York: Raven Press. p. 221–268.
5 Komárek V (2007). Léčba epileptických syndromu u dětí. [(Treatment of epileptic syndromes in children.) (In Czech with English abstract.)]. Cesk Slov Neurol N. **5**: 473–487.
6 Kuba R, Kára T, Brázdil M, Křížová J, Souček M, Novák M, *et al.* (2001). Neurokardiogenní synkopa-interiktální a iktální EEG studie. [(Neurocardiogenic syncope-interictal and ictal EEG study.) (In Czech with English abstract.)].Cesk Slov Neurol N. **2**: 100–108.
7 Kukumberg P (2007). Panická porucha-neuropsychiatrický profil. [(Panic disorder-neuropsychiatric profile.) (In Slovak with English abstract.)]. Cesk Slov Neurol N. **1**: 6–15.
8 Nešpor E (2007). Epilepsie a cyklus spánku a bdenia. [(Epilepsy and the sleep-waking cycle.) (In Czech with English abstract.)]. Cesk Slov Neurol N. **2**: 129–135.
9 Shinnar S, Kang H, Berg AT, Goldensohn ES, Hauser WA, Moshe SL (1994). EEG abnormalities in children with a first unprovoked seizure. Epilepsia. **35**: 471–476.
10 Sýkora M, Traubnerová R, Traubner P (2008). Bezpečnosť MRI vyšetrenia u pacientov s kovovými implantátmi a implantovanými prístrojmi. [(Safety of MRI in patients with metal implants and implantated devices) (In Slovak with English abstract.)]. Cesk Slov Neurol N. **1**: 47–52.
11 Vojtěch Z (2008). Klinická elektroencefalografie v epileptologii. [(Clinical electroencephalography in epileptology.) (In Czech.)]. Neurol. prax. **2**: 73–78.
12 Zivin L, Ajmone-Marsan C (1968). Incidence and prognostic significance of "epileptiform" activity in the EEG in non-epileptic subjects. Brain. **91**: 751–777.