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Original research article

Optimal time of duration of a long-term video-EEG monitoring in paroxysmal events – A retrospective analysis of 282 sessions in 202 patients

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ABSTRACT

Purpose: To find the optimal duration of the long-term video-EEG (LTM) and assess diagnostics utility of LTM in patients with epilepsy and other paroxysmal events in terms of future diagnosis and management.

Methods: Retrospective analysis of 282 LTMs performed in the last 5 years in our Epilepsy Monitoring Unit (EMU), in 202 consecutive patients. The analysis included demographic data, monitoring time, number and type of paroxysmal events, the time until their onset, influence of LTM result on the diagnosis and future management.

Results: There were 117 women and 85 men, mean age 34.2 years. Mean duration of LTM was 5 days (3–9), with 447 paroxysmal events recorded in 131 (65%) patients. Epileptic seizures were recorded in 82% cases (in 11% associated with PNES). The remaining 18% had either PNES (psychogenic non-epileptic seizures) – 11%, or parasomnias – 7%. Only 15% of epileptic seizures took place within the first 24 h of the LTM (53% and 32% on the 2nd and 3rd day, respectively), whereas as many as 62% of PNES did (while only 28% and 10% on the 2nd and 3rd day, respectively). The LTM results changed the diagnosis in 36% of the patients, most frequently in PNES (from 2% to 14%). Altogether, it changed the management in 64% of the patients – particularly with PNES and those who underwent epilepsy surgery.

Conclusions: LTM should last at least 72 h in patients with refractory epilepsy. Most of cases with PNES could be diagnosed after 48 h.

1. Introduction

Video-EEG monitoring (VEEG) consists of a simultaneous continuous recording of the patients' clinical situation and their electroencephalographic activity. This is either short-term, performed in outpatients and lasting on average 2–8 h or long-term (LTM), done in hospitalized patients. Outpatient VEEG is preferred both in children and adults who either have very frequent paroxysmal events or in whom the seizures can

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be reliably provoked [1,2]. Main indications for LTM base on the ILAE recommendations [3] and include: classification of seizure type or epileptic syndromes, differential diagnosis between epileptic seizures and other paroxysmal events, particularly psychogenic non-epileptic seizures (PNES) and parasomnias as well as assessing candidates for possible epilepsy surgery. In fact, LTM should be performed in every patient who despite appropriate AEDs suffers from frequent seizures or displays seizures with new symptomatology [4]. Duration of the LTM depends upon the clinical problem to be solved [3]. In a patient with one type of seizures and query about their origin (epileptic or not) or about epileptic syndrome, recording one typical event would be sufficient, whereas an analysis of a single seizure can neither decide the clinical questions in patients with several types of seizures, nor in candidates for epilepsy surgery. In the latter group, precise localization seizure onset zone is crucial for achieving a satisfactory surgical result and hence, for the prognosis [5].

This study was undertaken in an attempt to establish how long video-EEG monitoring should last depending on the reason for admission and what is influence of LTM on further diagnosis and management in patients with epilepsy and other paroxysmal events.

2. Material and methods

Our Epilepsy Monitoring Unit (EMU) is located in the Department of Neurosurgery and has a single station for long-term video-EEG monitoring (LTM). The procedure is supervised by a clinical neurophysiologist and an EEG technician, as well as in certain cases, by accompanying relatives. The patient is continuously watched on a monitor in nurses station. If required, nursing staff, junior doctor, neurosurgeon on-call and neurophysiologist on-call are readily available. The patient may leave the unit only if accompanied by a member of medical staff or family. The recording system used is Beehive horizon LTM (Grass Technologies, USA), with amplifiers Aura 32 or Aura 64 LTM (32- and 64-channel digital video-EEG system). Surface gold-cup electrodes were placed on a patient's scalp according to the international 10–20 system. Moreover, single channel ECG was also recorded and displayed on the monitor along with EEG. Some patients (60%) had their antiepileptic drugs (AEDs) doses reduced in order to increase the likelihood of a seizure. However, in patients with a history of status epilepticus the medication was never reduced.

If seizures occurred less frequently than once a week, in patients on monotherapy the dose of AED was reduced by 50%, in those taking two drugs, one of them was stopped and in the case of three drugs, one was stopped and another's dose decreased by half. The reductions applied to the drugs most recently commenced. No patient had the medication withdrawn. The patients stayed in the hospital for another day after reintroduction of the full dose of AEDs. No status epilepticus or cluster seizures as a result of reduction of doses of AEDs were observed. Similarly, there were neither injuries nor other side-effects of LTMs.

In patients who had more than one LTM, also sleep deprivation was used. In patients with a single type of seizures, usually, at least two events were recorded, whereas in all others, every type of seizure had to be taped.

In patients referred for pre-surgical evaluation, three habitual seizures were presumed as minimum to localize the seizure onset zone reliably.

All referrals for the LTM came from neurologists or neurosurgeons. The diagnoses on admission were as following: drug-resistant epilepsy – 140 (69%) cases, PNES – 4 (2%), symptomatic epilepsy (a potential epileptic focus seen on MRI) – 30 (15%), paroxysmal events of unclear nature – 8 (4%), a new type of seizures – 8 (4%) or increasing frequency of seizures – 12 (6%) occurring despite of AEDs.

2.1. *Statistical analysis*

Quantitative data were given as means, median and percentages. Two-proportion Z-test was used for determining the rate of increase of paroxysmal event detection over 3 monitoring days, as well as for evaluation of the utility of LTM for reaching the final diagnosis and modifying the treatment. A $p < 0.05$ was considered as significant.

3. Results

We analyzed retrospectively all LTMs carried out in our EMU in the last 5 years. There were 202 patients: 117 (58%) women and 85 (42%) men. Their mean age was 34.2 years (range 17–70, median 34). Duration of epilepsy ranged from 2 to 18 years.

In all, we performed 282 LTMs since 49/202 (25%) patients had more than one examination, namely, there were 2 recordings in 27 cases (13%), 3 in 13 (6%) and 4 in 9 patients (5%). The mean time of a recording was 5 days (range 3–9). There were 216 examinations lasting 72 h, 40–96 h, 7–120 h and 19 taking 216 h.

447 paroxysmal events were recorded in 131/202 (65%) patients. Amongst those, 31 (24%) patients had primary generalized seizures, 62 (47%) – complex partial seizures, including secondarily generalized seizures, 14(11%) cases – both epileptic seizures and PNES, 15 (11%) patients – PNES and 9 (7%) parasomnias. Hence, 107 (82%) patients had epileptic seizures (out of these 11% both epileptic psychogenic), whereas 24 (18%) had other paroxysmal events (11% of PNES and 7% of parasomnia).

Out of 62 patients with complex partial seizures, 39 (63%) had the seizure onset in temporal lobe (in 30 (70%) patients, the seizure onset zone was located in temporal mesial structures – MTLE), in 15 (24%) patients – in frontal lobe, in 5 (8%) – in occipital lobe, and finally, in 3 (5%) cases, the seizure onset zone was not defined.

Out of 9 patients with other paroxysmal events, 1 had facio-mandibular myoclonus, 2 – periodic limbs movements of sleep (PLMS), 2 – nocturnal paroxysmal dystonia (NPD) and finally 5 – narcolepsy.

The number of epileptic seizures and PNES recorded on consecutive days is given in Tables 1 and 2 as well as shown in histograms displayed in Figs. 1 and 2, respectively.

Seventy one patients (35%) had no paroxysmal events, but 27 (38%) of them had interictal epiletiform discharges (IEDs) which in 19 (70%) cases were recorded during the sleep.

Table 1 – The number of epileptic seizures recorded on the consecutive days.

Timing of diagnosis of epilepsy	LTM					
	Day 1		Day 2		Day 3	
	No of cases	Percent	No of cases	Percent	No of cases	Percent
Number of cases diagnosed on the previous day	–	–	16	14.95	73	68.22
Number of cases diagnosed each consecutive day	16	14.95	57	53.27	34	31.78
Number of the remaining undiagnosed cases	91	85.05	34	31.78	0	0.00
Total	107	100.00	107	100.00	107	100.00
Statistical analysis	Comparison of the rates of diagnosis on the 1st and 2nd day Z test: $Z_{1./2.} = -6.93$, $p \le 0.005$					

Table 2 – The number of PNES recorded on the consecutive days.

Timing of diagnosis of PNES	LTM					
	Day 1		Day 2		Day 3	
	No of cases	Percent	No of cases	Percent	No of cases	Percent
Number of cases diagnosed on the previous day	–	–	18	62.07	26	89.66
Number of cases diagnosed each consecutive day	18	62.07	8	27.59	3	10.34
Number of the remaining undiagnosed cases	11	37.93	3	10.34	0	0.00
Total	29	100.00	29	100.00	29	100.00
Statistical analysis	Comparison of the rates of diagnosis on the 1st and 2nd day Z test: $Z_{1./2.} = -0.63$, $p \ge 0.05$					

LTM established the diagnosis in 158 (78%) patients, 131 with recorded seizures and 27 with IED. In 42 (22%)cases, LTM did not give the diagnosis.

LTM helped to change a diagnosis in 70 (35%) cases. The account of these cases is given in Table 3. Statistical analysis proved that LTM was a very useful diagnostic tool as changing the diagnosis was more likely than confirming it. This was true in the whole group (129/158 vs. 29/158, $U = 11.25$, $p < 0.001$) as well as in the patients with epilepsy (93/120 vs. 27/120, $U = 8.52$, $p < 0.001$) and PNES (13/15 vs. 2/15, $U = 4.02$, $p < 0.001$).

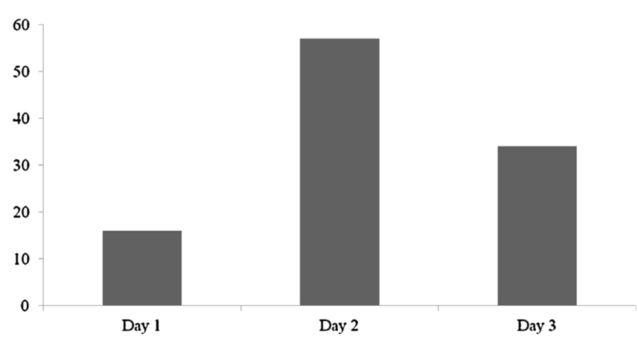

Fig. 1 – Number of epilepsy cases diagnosed on each consecutive day.

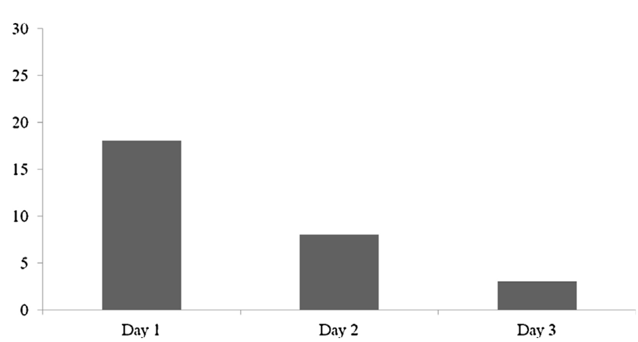

Fig. 2 – Number of PNES cases diagnosed on each consecutive day.

Statistically, the findings of LTM resulted more likely in a change of medical treatment than to leave the medication unchanged (128/202 vs. 74/202, $U = 5.37$, $p < 0.001$).

Sixty-two out of 202 (31%) patients were subsequently operated on.

4. Discussion

According to the demographic analysis the mean age of our patients was 34 years (range 17–70), but the majority – 2/3 of all were the patients in the 3rd and 4th decade of life (39% and 27%, respectively). In other studies on LTM in adults, the mean age of the patients is either similar or slightly greater – within the range 34–40 years [6–10], only in a study of Baheti et al. [11], it reaches 51 years, however, this particular study concerns patients older than 45. Consistently with other reports [7,8,10], we noted certain preponderance of women (58%). The greatest number was given by Baheti et al. [11] – 66% females. Exceptionally, a group of Lee et al. [6] consisted in majority of men (56% out of 129 subjects). The mean time of the LTM in our EMU was 5 days, whereas in other studies it ranged from 2 to 5.6 days [6–11]. One of the methods saving the time is to gradually taper or withdraw AEDs. This facilitates recording of the seizures sooner or in a greater number [3,6,9]. Although this method is accepted and widely used, to-date no uniform protocol has been worked out [3]. Amongst our patients, 60% had their AEDs reduced by half, both in mono and polytherapy, but no patient had them totally withdrawn. In contrast,

Table 3 – Influence of LTM for the diagnosis.

Diagnosis before the LTM	Diagnosis after the LTM	No of patients
Primary generalized seizures	Complex partial seizures	12
Complex partial seizures	Primary generalized seizures	8
PNES	Complex partial seizures	2
Paroxysmal events of unclear nature	Parasomnia	8
Simple partial seizures	PLMS	1
Refractory epilepsy	PNES	13
Refractory epilepsy	Epi and PNES	14
Symptomatic epilepsy (pathology seen on MRI)	Primary generalized seizures – 8 or other focus than seen on MRI	12
	Total	70

Lee et al. [6] reduced the dose by half on the first day, however, providing there was no seizure, withdrew AEDs altogether on the following day. On the other hand, Hui et al. [9] curtailed AEDs by 50% still before the admission for LTM, and if until the 3rd day there were no seizures, the medication was halted up to the 6th day. According to many the withdrawing of AEDs for LTM may be potentially dangerous, as it carries 3% risk of a status epilepticus or cluster seizures [7,12–14]. Although, neither us nor a number of other authors observed no complications related to the dose reduction of AEDs [6,9,10], it is obvious that defining clear indications for AEDs reduction as well as an algorithm to be followed in EMUs performing LTM, would be of undisputable advantage.

Although less frequently employed, sleep deprivation is yet another method which may trigger seizures. We used it in every patient who had more than one LTM i.e. in 25% of the cases. In the literature, sleep deprivation is also recommended in 25% of cases [10], albeit according to Glick [15], it is less effective than withdrawing AEDs.

Paroxysmal events were recorded in 131 patients (65%), which gives 3.4 events per patient.

Interestingly enough, only 15% of epileptic seizures took place within the first 24 h of the LTM (53% and 32% on the 2nd and 3rd day, respectively), whereas as many as 62% of PNES did (while only 28% and 10% on the 2nd and 3rd day, respectively). The similar pattern of frequency distribution of seizures was reported by Atkinson et al. [4]. In contrast, Villanueva et al. [10] did not observed any differences in timing of the first paroxysmal event recorded on LTM in epilepsy and PNES. In their material the mean time until the first seizure was 30 h, although in as many as in 60% of the patients the first event was recorded within the first 24 h. Our data suggest that 48-h-monitoring is too short for patients with epilepsy, but may suffice in PNES cases. Hence, our observation undermines opinions of authors who recommend 48-h-LTM as fully diagnostic [6] and those who claim that preoperative assessment can be done in an outpatient clinic [16].

In 78% of our patients LTM was diagnostic. This percentage is similar to reported by other authors, which ranges from 68 to 80% [7–9,17,18]. In the patients in whom LTM did not give the diagnosis we recommended to perform it again after sleep deprivation and/or reduction of AED. The result of LTM confirmed the diagnosis of epilepsy, identified the patients with PNES, including those with coexisting epileptic seizures, facilitated diagnosis of parasomnias and indicated candidates for epilepsy surgery.

It is worthwhile to notice that in 36% of our cases LTM changed the preliminary diagnosis. According to the literature this happens in 13–65% of patients [7–10]. In this group particular attention should be drawn to patients with PNES, who constituted 14% of our cases (in half of them PNES coexisted with epilepsy). This number is slightly greater than given by majority of authors i.e. 9.5–12% [3,6,7,9,11] but lower than 24% reported by Ghougassian et al. [8] Despite the fact that all our patients were referred for LTM by either a neurologist or a neurosurgeon, only 2 patients (7%) put of 29 with PNES were correctly diagnosed prior to the monitoring. Some authors claim that the patient with PNES make up to 20% of all cases referred by neurologists or even epileptologists to centers for patients with drug-resistant epilepsy [19–21] and it is not unusual that the correct diagnosis is made as late as after 7 years from the onset [22]. This confirms that PNES is difficult to diagnose and that LTM should be a gold standard in patients with this condition [6]. Patients in whom LTM showed PNES require psychiatric attention and psychotherapy. If PNES is the only pathology they should have their AED withdrawn, whereas in the cases with both epilepsy and PNES this treatment should be continued.

LTM influenced the management in 68% of our patients. In the literature this percentage ranges from 40 to 73% [6–10]. As mentioned before, the largest group in which the management was altered after LTM, consisted of the patients with PNES. The other group of patients who benefited in this way were those eligible for epilepsy surgery. We had 62 such patients (31%), a number similar to the reported in the literature – 25–36% [7,10,11].

5. Conclusions

LTM is absolutely necessary in the evaluation of refractory epilepsy and other paroxysmal events.

LTM should last at least 72 h in patients with refractory epilepsy. Most of cases with PNES could be diagnosed after 48 h.

Conflict of interest

All authors declare that there is no actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations that could inappropriately influence, or be perceived to influence, their work.

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Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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