Epilepsy Research 125 (2016) 19–23

Contents lists available at www.sciencedirect.com

Epilepsy Research

journal homepage: www.elsevier.com/locate/epilepsyres

Can home video facilitate diagnosis of epilepsy type in a developing country?

Deepa Dash, Anubha Sharma, Kunwar Yuvraj, Appukutan Renjith, Santosh Mehta, Padma Madakasira Vasantha, Amit Arora, Manjari Tripathi *

All India Institute of Medical Sciences, New Delhi, India

ARTICLE INFO

Article history:
Received 22 June 2015
Received in revised form 26 March 2016
Accepted 21 April 2016
Available online 12 May 2016

Keywords:
Home video
Semiological features
Video EEG
Epilepsy monitoring unit
Mobile phone

ABSTRACT

Objectives: The study aimed to evaluate the feasibility and yield of semiological features from home videos and compare them to those inferred from history provided by the caregiver of a person with epilepsy (PWE). A comparison of the accuracy of classification of epilepsy based on home videos and medical history was also done.

Methods: We enrolled PWEs who were awaiting admission for video electroencephalography (VEEG) to the epilepsy monitoring unit (EMU) in this prospective observational study. In phase I of the study, we encouraged caregivers to make home videos which were analyzed. A structured questionnaire dealing with 29 different semiological features was completed based on the information gathered from home videos. In phase II of the study, the questionnaire was administered to the patient's caregivers. In phase III the patients underwent VEEG recording, and the semiology from VEEG was analyzed to complete the same questionnaire. We also classified epilepsy type using home videos and medical history and compared it to that using VEEG finding. The information gathered from VEEG was considered the gold standard. Accuracy was calculated for the different semiological signs comparing medical history to VEEG findings.

Results: A total of 340 PWE fulfilled the inclusion and exclusion criteria, and their caregivers completed the questionnaire. Home videos were collected from 312 patients and 624 seizures were analyzed. The mean number of signs of semiology recorded after analysis of home videos was 3.3 ± 2.2, and from the medical history was 2.1 ± 1.1 ($P < 0.01$). A total of 572 seizures in 282 patients admitted in the EMU were evaluated on VEEG. Bilateral generalized clonic movements of limbs, motor movement around mouth, fear, visual phenomenon, hemisensory phenomenon, and post-ictal unilateral weakness had the highest accuracy. The overall agreement of semiological signs inferred from medical history versus VEEG was 0.75 and between home video recordings versus VEEG was 0.92. A larger number of patients were correctly categorized into the focal epilepsy group when home videos were used to classify compared to when medical history was used.

Conclusions: Home videos are more reliable in picking up semiological signs and classifying epilepsy type than history provided by caregivers of PWEs. Home videos are a complementary tool in a developing country like India.

1. Introduction

The diagnosis and management of a PWE is based on an accurate historical description of the ictal event. An accurate description helps in correctly classifying seizure type and epilepsy syndrome. It also guides the physician in starting the appropriate antiepileptic drug (AED) for the PWE. In patients with drug-resistant epilepsy (DRE), the description of semiology also helps in the lateralization and localization of the possible ictal onset zone. This is important for building a hypothesis before the patient undergoes other presurgical investigations for epilepsy surgery.

Clinical practice information regarding seizure semiology is usually obtained from the patient's caregivers, which usually includes family and friends who have witnessed the seizures. Several factors influence the accuracy of description given by the caregiver. Anxiety, distress, alarm, and confusion during the ictal event are

* Corresponding author at: Center of Excellence Epilepsy, Department of Neurology, All India Institute of Medical Sciences, New Delhi 110029, India.
E-mail address: manjari.tripathi1@gmail.com (M. Tripathi).

http://dx.doi.org/10.1016/j.eplepsyres.2016.04.004
0920-1211/

common limiting factors. In addition, the limited repertoire of descriptive terminologies in a population with poor educational background restricts the seizure narrative. The gold standard for determining semiology is the VEEG recording. VEEG is a resource and labor intensive investigation and is available at very few centers in a developing country like India. Several studies have focused on the accuracy of investigations like EEG, ictal SPECT, positron emission tomography (PET) etc., but literature is scarce regarding the accuracy of semiological features inferred from the description of the caregiver, particularly from developing countries. We conducted this study with two objectives. The first was to evaluate the diagnostic yield of different semiological signs inferred from the description of the caregivers. The second was to evaluate the role of home video recordings in picking up seizure phenomenology and classifying epilepsy type in this cohort.

2. Methods

This was a prospective observational study conducted in three phases from April 2008 to April 2012 in a tertiary care teaching hospital in India. PWEs who were waiting admission to the EMU either for characterization of seizure type or as the first step for non-invasive presurgical evaluation (in patients not responding to two or more antiepileptic drug therapy) were included after giving informed consent. PWEs were included in the study only if their caregivers were motivated to make videos of seizure episodes and could understand written Hindi and/or English. PWEs were excluded from the study if they: (1) had a history of multiple seizure types (defined as occurrence of more than one type of seizure: generalized tonic, atypical absences, myoclonic, and generalized tonic-clonic seizures), (2) a history suggestive of psychogenic non-epileptic seizures (PNES), (3) were not eligible for EMU recording (because of pregnancy or metabolic disorders), or (4) had a caregiver who was not staying with the PWE for more than 2 years or two-thirds of every day. Demographic details of caregivers including their age and gender, their educational level, and relationship to the PWE were also recorded.

A structured questionnaire was devised to record the seizure phenomenology. This questionnaire had 29 points dealing with different possible semiological features. Each point addressed commonly observed phenomenology of a seizure episode. The 29-point questionnaire (Table 1) was developed by two epileptologists based on the commonly encountered semiological signs in clinical practice (MT, AA). The questionnaire was translated from English into Hindi by experts in the Hindi department of the All India Institute of Medical Science, translated back to English, and corrected in the Hindi version. It was then administered to a group of 20 caregivers of PWEs and modifications were made according to the feedback received. The feasibility of administering the questionnaire was established, and then it was administered to the study cohort.

2.1. The study was conducted in three phases

2.1.1. Phase I

In the first phase of the study, caregivers of patients awaiting admissions to an EMU were encouraged to make home videos of the ictal event. The caregiver was instructed to record a minimum of 3 or more home videos of the habitual ictal events. The two best videos were taken for analysis. The videos were assessed for quality according to the Quality of Video (QOV) scale, which was developed by MT to quantitatively measure the quality of videos. The QOV scale had 11 items, each of which was given points ranging from −1 to 2. Two points were given if a full view of the face and/or whole body was visible and if the event was recorded from the very beginning. One point was given if part of the face and/or body were visible, or if there was adequate illumination and the recording included post-ictal events. One point was deducted if the view of the patient was obscured by the caregiver and/or movement, or if the recording was done too close to or too far from the patient.

The maximum score for the QOV scale was 10. A score of 1–4 was considered poor quality, 5–7 moderate quality, and 8–10 good quality. These videos were analyzed for semiological features by MT & AA. The questionnaire was completed based on the phenomenology observed on the home videos, and a diagnosis of the type of epilepsy was made.

2.1.2. Phase II

The second phase of the study was conducted when the same PWE was admitted to the EMU for a VEEG recording. The questionnaire was administered to the PWEs caregivers by a trained epilepsy resident. Caregivers had to identify whether the patient had the specific features described in the questionnaire. Finally, based on the features in the questionnaire, a diagnosis of the type of epilepsy was made.

2.1.3. Phase III

After admission to the EMU, the patients underwent VEEG recording following a gradual AED tapering protocol. Seizure semiology from the VEEG recording was analyzed by an epileptologist (MT) and the 29-point questionnaire was again completed and classification of the type of epilepsy was made. The information gathered from VEEG was considered to be the gold standard.

We calculated the sensitivity (SN), specificity (SP), false positive rate (FPR: false positive/[false positive + true negative]), false negative rate (FNR: false negative/[false negative + true positive]), and accuracy (ACC: [true positive + true negative]/all patients included)

Table 1
The English version of 29 point questionnaire.

	Semiology sign description
1.	He/she stares blankly and does not respond to commands.
2.	He/she speaks words (irrelevant) during the episode.
3.	He/she makes sounds (irrelevant) during the episode.
4.	He/she complaints of abnormal sensation in half of body (warmth/tingling/cold).
5.	My patient complaints of dizziness during the episode.
6.	My patient complaints of headache during the episode.
7.	There is involvement of one side (leg/hand) but don't know which side.
8.	There is involvement of one side and it is right/left.
9.	My patient has involvement of one side and is not aware of the surrounding.
10.	There is abnormal movements around mouth, chewing/lip smacking.
11.	My patient complains of coloured spots, black spots or objects during the episode.
12.	There is rhythmic jerky movements of one limb(leg/hand)
13.	There is rhythmic jerky movements of both limbs(hands/legs)
14.	There is tightening of one limb(leg/hand).
15.	There is tightening of both limbs(leg/hand).
16.	There is rhythmic jerky movements of all four limbs.
17.	There is abnormal feeling of something rising in my stomach.
18.	There is abnormal twisting/posturing of one limb.
19.	There is feeling of fear during the episode.
20.	There is first involvement of one limb(hand/leg and then all 4 limbs get involved.
21.	There is abnormal searching movement of one hand.
22.	There is abnormal searching movement of both hands.
23.	He/she complains of smells(pleasant/unpleasant).
24.	He/she complains of buzzing sounds.
25.	Not sure if starts from one side or all 4 limbs.
26.	His head and eye turns towards one side in the beginning of seizure.
27.	The time of the episode a. <1 min b. 1–5 min c. >5 min
28.	My patient complains of vague feeling and discomfort during the episode.
29.	There was weakness/inability to move or grip my hand/leg after the event.

of the phenomenology signs recorded in the questionnaire based on history provided by the caregiver, considering VEEG findings to be the gold standard. We divided semiological features into three groups based accuracy: high (>85%), moderate (66–84%), and low (≤65%). We also determined the measure of agreement (k) between the completed items on the questionnaire based on medical history versus VEEG and home videos versus VEEG. Agreement on signs of semiology was measured between the questionnaire completed on the basis of medical history and home videos and the questionnaire completed on the basis of VEEG recordings (gold standard). The interobserver agreement was done using kappa statistics. Kappa values were interpreted according to the following values: no agreement (k = 0), slight (0.01–0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8), and almost perfect agreement (>0.8).

3. Results

A total of 420 patients were screened; of these 340 fulfilled the inclusion and exclusion criteria and were enrolled in the study following after giving informed consent. The mean age of our patients was 26.76 ± 7.5 years. In our cohort of PWEs, parents were the most common primary caregivers (82%), followed by siblings (6.8%), others (6.8%), and spouses (4.4%). The majority of the caregivers had only a primary school education (36.2%), followed by significant proportions who were uneducated (28.8%). Only 22.3% had secondary school education and 12.6% were graduates/post graduates.

Table 2
Quality of videos (QOV) of home video recordings.

QOV Score	Number of videos total n = 624
1–4	127 (20.3%)
5–7	330 (52.9%)
8–10	167 (26.8%)

Out of 340 patients, 312 could provide home videos. The reasons for inability to make videos in descending order of frequency were short duration of seizures, nocturnal seizures, non-availability of caregiver during the ictus, and lack of immediately availability of a tool (mobile phone/camera) to make a video. A total of 624 videos were analyzed and scored (DD). Table 2 depicts the QOV scores of videos obtained from our patients. On analysis of QOV, it was found that only 2% of patients could record the onset of seizures and all these patients had premonitory symptoms or a prolonged aura.

In the second phase of the study, 312 PWEs were admitted to the EMU. During the PWEs stay, their caregivers were administered the structured questionnaire pertaining to the semiological features by a resident in the EMU.

Of the 312 patients enrolled with a suspected seizure diagnosis, 30 patients (9%) were found to have PNES after the EMU VEEG. A parallel study exploring the role of home videos in diagnosis of PNES was ongoing; hence, we had excluded these patients from our study.

Table 3
Sensitivity, specificity and accuracy of different signs of semiology.

Semiology description	Semiology sign	Sensitivity	Specificity	Accuracy	
There is rhythmic jerky movements of all four limbs.	Bilateral generalized clonic movements of all limbs	88%	88%	86%	High accuracy
He/she makes sounds (irrelevant) during the episode.	Vocalization	65%	88%	88%	
There is abnormal movement around mouth like chewing or lip smacking.	Motor movement around mouth	96%	87%	88%	
There is feeling of fear during the episode.	Feeling of fear	65%	98%	93%	
My patient complains of coloured spots, black spots or objects during the episode.	Visual phenomenon	64%	98%	88%	
He/she complaints of abnormal sensation in half of body (warmth/tingling/cold).	Hemi sensory phenomenon	69%	90%	88%	
There was weakness/inability to move or grip my hand/leg after the event.	Post ictal Unilateral weakness	89%	98%	96%	
There is involvement of one side (leg/hand) but don't know which side.	Focal without Sidedness	78%	72%	72%	Moderate accuracy
He/she complains of buzzing sounds.	Auditory aura	22%	86%	76%	
There is first involvement of one limb(hand/leg and then all 4 limbs get involved.	Focal going on to become generalized	29%	71%	70%	
There is rhythmic jerky movements of one limb(leg/hand)	Clonic Unilateral	45%	69%	68%	
My patient complaints of headache during the episode.	Headache	81%	81%	81%	
My patient complains of vague feeling and discomfort during the episode.	Vague sensation	43%	77%	66%	
He/she complains of smells(pleasant/unpleasant).	Olfactory aura	67%	70%	68%	
My patient complaints of dizziness during the episode.	Dizziness/vertigo	81%	71%	70%	
There is rhythmic jerky movements of both limbs(hands/legs)	Clonic movements of both extremity	82%	68%	70%	
There is tightening of both limbs(leg/hand).	Tonic both extremity	74%	68%	67%	
There is abnormal searching movement of one hand.	Searching movement of one upper limb	78%	59%	69%	
There is abnormal searching movement of both hands.	Searching movement of both upper limbs	58%	78%	68%	
He/she speaks words (irrelevant) during the episode.	Verbalization	71%	60%	66%	
There is abnormal feeling of something rising in my stomach.	Epigastric rising	78%	77%	78%	
My patient has involvement of one side and is not aware of the surrounding.	Focal with loss of awareness	81%	21%	57%	Low accuracy
There is tightening of one limb(leg/hand).	Tonic posturing of an extremity	81%	28%	40%	
There is abnormal twisting/posturing of one limb.	Asymmetry in posture	21%	17%	20%	
His head and eye turns towards one side.	Versive Movement	18%	28%	24%	
Not sure if starts from one side or all 4 limbs.	Uncertain if Focal or Generalized	44%	22%	27%	
The duration of the episode a. <1 min b. 1–5 min c. >5 min	Total time	76%	17%	28%	
There is involvement of one side and it is right/left.	Focal with sidedness	34%	29%	30%	
He/she stares blankly and does not respond to commands.	Blank spell	84%	19%	36%	

Table 4
Comparison of categorisation of epilepsy into focal and generalized based on medical history, home videos and VEEG.

Type of seizure	Medical History	Home videos	VEEG
Generalised epilepsy	100 (35.4%)	72 (25.5%)	41 (14.5%)
Focal epilepsy	142 (50.3%)	210 (74.5%)	241 (85.5%)
Could not categorize	40 (14.2%)	0	0

Table 5
Localization of the seizures after medical history, home videos and Video EEG telemetry.

Lobar/sub lobar localization	Medical history	Home videos	VEEG analysis
Temporal	18.4%	44.5%	35.1%
Frontal	14.8%	5.8%	10.9%
Occipital	9.2%	5.2%	9.2%
Parietal	8%	3%	6%
Frontotemporal	–	–	3.5%
Temporo-occipital	–	–	7.1%
Central	–	–	2.5%
Hemispheric	–	–	7.4%
Others, e.g. Pseudo temporal	–	–	3.5%

In Phase III of the study patients underwent VEEG, and a total of 572 seizures in 282 patients admitted to the EMU were evaluated by an epileptologist and the epilepsy fellow (MT, AA).

The mean number of semiology features recorded after analysis of home videos was 3.3 ± 2.2, whereas it was 2.1 ± 1.1 after using history obtained from caregivers and was 4.9 ± 1.5 after analysis of VEEG recordings. When we compared the mean number of semiology features between home videos and medical history, a significantly higher yield was obtained from home videos ($p < 0.01$).This shows that a larger number of semiological features were picked up by home videos compared to the history provided by the caregiver. The overall interobserver agreement of semiological signs inferred from medical history versus video EEG was 0.75, and between home video recordings versus VEEG was 0.92.

Sensitivity, specificity, and accuracy analysis of each semiology-related sign was done comparing the medical history to the gold standard of VEEG. Table 3 depicts the sensitivity, specificity, and accuracy of the different signs of semiology classified as high (>85%), moderate (66–84%), and low (≤65%).

Table 4 depicts the classification of patients into generalized and focal epilepsy based on the semiology described by the medical history, home videos, and VEEG telemetry. Details regarding the final localization of the epilepsy after analyzing VEEG, home videos and medical history have been tabulated in Table 5. A larger number of patients could be correctly categorized as having focal epilepsy based on home videos compared to medical history alone. When both home videos and medical history were used to classify epilepsy, 78.2% of patients were correctly categorized as having focal epilepsy.

4. Discussion

The diagnosis of epilepsy relies on the historical account given by the eyewitness. Other tools can add valuable information regarding semiology, thus contributing to a correct diagnosis. Home videos are simple, widely available, and inexpensive tools for gathering accurate information regarding seizure semiology. Literature exploring the role of home videos in making a correct diagnosis and classifying the type of epilepsy is scarce. This study was conducted with the aim of first evaluating the accuracy of semiological signs inferred from history provided by caregivers in a developing country. Our second objective was to compare the yield of home videos versus medical history in identifying semiology features and correctly classifying the type of epilepsy.

When the accuracy of history was calculated, features like bilateral generalized clonic movements of limbs, motor movement around mouth, fear, visual phenomenon, hemisensory phenomenon, and post-ictal unilateral weakness had the highest accuracy, whereas features like focal onset with loss of awareness, focal with one-side involvement, blank spells, versive movement, asymmetry in posture, tonic posturing of one limb and duration of seizure had the lowest accuracy. This suggests that semiological features that help in making a diagnosis of focal epilepsy were more likely to be missed when history alone was used to classify epilepsy. Home video is a simple and inexpensive tool, which is easy to use and can give better information in a developing country.

Overall the interobserver agreement of semiological signs inferred from medical history versus VEEG was 0.75, and between home video recordings versus VEEG was 0.92. Thus, home videos were a more reliable tool for observing semiological features than medical history. We also found that more than 75% of the home videos made by caregivers, with motivation from the clinician, had a score in the range of 5–10 QOV scale. This shows the feasibility of using home videos for classifying epilepsy type. We also found a significantly higher number of patients were correctly categorized as either focal or generalized epilepsy after use of home videos compared to medical history (VEEG used as the gold standard). Thus, home videos are better than history from caregivers in classifying epilepsy type. When both home videos and medical history were used to classify epilepsy, 78.2% patients were correctly categorized as having focal epilepsy. Thus, when history is supplemented with information from home videos the probability of correctly classifying epilepsy type increases.

Hirfanoglu et al. (2007) evaluated the reliability of the seizure classification based on semiology in 90 patients. They classified seizures based on the medical history obtained from the parents of patients and subsequently on VEEG monitoring. A larger proportion of patients were categorized as having simple partial seizures based on the history taken from caregivers compared to when VEEG monitoring was used to categorize patients. A similar trend was also observed in our study; semiological features with a motor component had the maximum yield from the caregiver's history. We also found a higher number of patients wrongly categorized as having generalized epilepsy when medical history was used to classify epilepsy type compared to when home videos were used.

Heo et al. (2008) in a study of 92 patients, compared the semiology described by the observers with the semiology recorded on the videotape. They reported that oral automatisms and tonic/dystonic posturing was well described by observers. Oral automatisms as a semiological feature were reported with high accuracy in our study, but there was low accuracy in reporting of tonic/dystonic posturing of an extremity. Heo et al. also reported that there was poor recall for laterality although there was good recall for the presence or absence of lateralizing signs. Our study also found a low accuracy of sidedness; most often there was a mirroring effect with right to left confusion, and the incorrect side was perceived by the caregiver.

Besocke et al. (2009) evaluated the accuracy of various components of semiology in patients with partial epilepsy based on medical history. They reported that complex automatisms, autonomic alterations, negative motor signs, tonic asymmetric postures, and language disturbances had high accuracy. They used an open format interview whereas we used a structured questionnaire to decrease bias and susceptibility to suggestions by the interviewer. In contrast to their findings, we found a moderate accuracy for complex automatisms, language disturbances, and autonomic alterations, and low accuracy for tonic asymmetric posturing.

In a setting with limited resources like ours, home video is a tool which is widely available due to widespread use of mobile phones, which are easy to use and not technologically challenging.

We found a significantly higher number of semiological features being identified by home videos compared to the history provided by the caregiver. We also found a high interobserver agreement for semiological signs between home video recording versus VEEG (0.92), thus proving the reliability of the tool. We also found a significantly larger number of seizures classified correctly into the focal group using home videos versus using only medical history. Although the caregivers were not very educated, with motivation a majority of them could make home videos of acceptable quality. More than 50% of the videos had a QOV score of 5–7.

Beniczky et al. (2016) assessed the accuracy of seizure semiology interpretation inferred by history provided by the witness and from video recording. They reported a higher measurement of agreement with the reference standard for videos than the measurement of agreement inferred from the historical description. A similar trend was seen in our study as a higher number of semiological signs were picked up from home videos compared to the number of signs from the history obtained from the caregiver.

Our study had a few limitations. First, the use of a structured questionnaire instead of an open format made the interview more restrictive. Though we confirmed with the caregivers that the recorded seizures were the habitual ones, subtle changes in ictal signs might have occurred and might not be obvious or recognized by the witness. Only 2% of our caregivers could make a video from the beginning of a seizure, thus the very initial phase of seizure onset might have been missed by home videos. In a real-life scenario, it was very difficult to capture the onset of a seizure on home video, but nevertheless a lot of information can still be obtained if the events occurring before secondary generalization are captured. This will vary from patient to patient, but the expected time would range from few seconds to a minute. This is where the documentation of clinical observations will be essential in filling in the missing information regarding the onset of the seizure. We compared the signs by caregivers to those picked up by the neurologist, and this could also be the reason for a higher yield of signs of semiology in the home videos. Also, we included patients who had only a single seizure type and excluded those who had more than one type of seizure. Finally, home videos and the caregiver's history are complementary, and when information derived from both are analyzed together it further enhances and helps in making a proper diagnosis and categorization of epilepsy type.

Our study is the only published study to systematically evaluate the accuracy of home videos in assessing semiological signs in PWE. India has the second largest percentage of mobile phone users and this valuable tool had never before been evaluated for assessing a PWE (http://en.wikipedia.org/wiki/List_of_countries_by_number_of_mobile_phones_in_use). The results of our study show that the widespread availability of mobile phones, even in the rural areas of the country, can be harnessed to capture seizures and classify epilepsy accurately. This will have long-term implications for patient management and also for clinical research of PWEs in India.

Disclosure statement

None of the authors has any conflict of interest to disclose. The study is part of work of Center of excellence Epilepsy, BT/01/COE/09/0, Department of Biotechnology.

References

Beniczky, S.A., Fogarasi, A., Neufeld, M., Andersen, N.B., Wolf, P., van Emde Boas, W., et al., 2016. Seizure semiology inferred from clinical descriptions and from video recordings. How accurate are they? Epilepsy Behav. EB 24 (2), 213–215.

Besocke, A.G., Rojas, J.I., Valiensi, S.M., Cristiano, E., Garcia del, M.C., 2009. Interview accuracy in partial epilepsy. Epilepsy Behav. EB 16 (3), 551–554.

Heo, J.-H., Kim, D.W., Lee, S.-Y., Cho, J., Lee, S.-K., Nam, H., 2008. Reliability of semiology description. Neurologist 14 (January (1)), 7–11.

Hirfanoglu, T., Serdaroglu, A., Cansu, A., Bilir, E., Gucuyener, K., 2007. Semiological seizure classification: before and after video-EEG monitoring of seizures. Pediatr. Neurol. 36 (April (4)), 231–235.