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Video-ambulatory EEG in a secondary care center: A retrospective evaluation of utility in the diagnosis of epileptic and nonepileptic seizures

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ABSTRACT

The development and optimization of protocols using simultaneous video recording alongside long-term electroencephalography (EEG), such as ambulatory EEG (AEEG), expanded the range of available techniques for the investigation of paroxysmal clinical events. In particular, video-AEEG has received increasing attention over the last few years because of its potential to further improve diagnostic utility in the differential diagnosis between epileptic and nonepileptic seizures. We retrospectively evaluated 88 video-AEEG studies in order to assess the diagnostic utility of video-AEEG in 87 patients consecutively referred to a neurophysiology department. Typical clinical events occurred during 55 studies (62.5%). In 26 of these, at least one event was also clearly seen on video recording, contributing to a confident diagnosis. Clinical events were classified according to three diagnostic categories: epileptic seizures (6 studies, 6.8%), physiologic nonepileptic events (13 studies, 14.8%), or psychogenic nonepileptic seizures (36 studies, 40.9%). Of the studies with an event not recorded on video, a confident diagnosis could be reached in 55.2% of cases. The main reason for unsuccessful video recording was failure to activate the camcorder by the patient or carer. We found an overall diagnostic utility of 67.0%, which confirms the findings of previous reports evaluating the diagnostic yield of AEEG. Implementation of video-AEEG protocols in a secondary care center appears to have high diagnostic utility, particularly for patients with psychogenic nonepileptic seizures. Our findings prompt further research into the potential applications of video-AEEG, in consideration of important implications for successful patient management and healthcare resource allocation.

1. Introduction

Long-term electroencephalography (EEG) is an established investigation for adult and pediatric patients with paroxysmal clinical events raising the diagnostic possibility of epilepsy [1,2]. Ambulatory EEG (AEEG) has been suggested as a cost-effective alternative to inpatient video-telemetry (IVT), which is particularly useful in assisting the differential diagnosis between epileptic seizures and psychogenic nonepileptic seizures (PNES) [3–6]. Recording a patient in their natural environment provides the additional benefits of limiting potential confounders because of the artificial environment of the epilepsy monitoring unit and reducing disruption to daily activities. In addition to its use in determining the nature of paroxysmal events, AEEG has been proposed to have an important role in accurately determining seizure frequency [7], aiding presurgical evaluation [8,9], and predicting seizure recurrence following withdrawal of antiepileptic medication [10].

One of the main disadvantages of AEEG is the inability to witness seizure semiology. This leads to potential for labeling epileptic seizures with no EEG correlate as nonepileptic, and conversely mistaking nonepileptic seizures for epileptic seizures because of misinterpretation of rhythmic artifact. Particular seizure types are recognized to have little or no corresponding EEG change or to result in excessive artifact, thus, challenging EEG interpretation [11–13]. Video recording has been shown to increase the diagnostic yield of routine outpatient EEG [14,15], allowing epilepsy specialists to witness seizure semiology, and video-EEG is currently recognized as the recommended gold-standard in the diagnosis of PNES [16,17]. The development and optimization of protocols using simultaneous video recording alongside AEEG (video-AEEG) has received increasing attention over the last few years because of its potential to further improve diagnostic utility [18–20].

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In this paper, we present the results of a retrospective service evaluation with the primary aim of assessing the diagnostic utility of video-AEEG in a large group of patients referred to a neurophysiology department.

2. Methods

All patients referred for AEEG at a neurophysiology department within a secondary care center over a 20-month period were retrospectively reviewed. Medical records, referral letters, patient diaries, and EEG reports were independently analyzed by two clinicians. A total of 101 video-AEEG studies were performed, with regional referrals coming from neurology (N = 75), pediatric neurology (N = 17), neuropsychiatry (N = 7), neurorehabilitation (N = 1), and stroke medicine (N = 1). Referral criteria stipulated that patients experienced at least two clinical events per week. Insufficient clinical information was available for 9 cases referred from other centers, resulting in exclusion of these patients from further analysis. Two studies failed because of technical problems with recording equipment (both successfully repeated at a later stage), and two further studies failed because of patient-related factors (one patient had an allergy to recording electrodes, one patient withdrew consent). Therefore, 88 video-AEEG studies (on 87 patients) were successfully completed and included in our analysis.

Ambulatory EEG recording was performed using an XLTEK 32-channel recording system with a sampling rate of 500 or 250 Hz per channel. Twenty-one silver chloride electrodes were applied according to the International 10–20 electrode placement system using collodion and further secured using a head-net when required, mainly in children. Patients received a letter detailing the test procedure in advance and were further counseled by a senior clinical physiologist prior to the study. Patients were provided with a clinical diary to be completed concurrently and instructed to activate an event marker. They were asked to return to the neurophysiology department every 24 h to change batteries, check electrode placement and impedance, download data, and assess need for continued recording. Optimal impedance was below 5 kΩ.

Video recording was performed with an off-the-shelf integrated Trex HD (XLTEK, USA) camcorder. Up to 48 h of high-definition video can be recorded on a standard memory card, which is time-locked to the AEEG via bluetooth connection. Infrared mode allows nighttime recording. Battery life is up to two hours and continuous recording, therefore, requires connection to a mains supply. Patients were trained in the use of the camcorder, and standardized instructions were provided to each patient/guardian, in order to optimize positioning of the camera in the home environment and avoid unnecessary covering of the body during the recording period. All studies were reviewed by a clinical physiologist and reviewed in full and reported by the same senior consultant experienced in EEG interpretation (FM). All patients or guardians gave written consent for data to be used for research purposes, and based on their distribution, all data were analyzed using Fisher's exact test. Research on secondary use of anonymized information previously collected as part of routine care delivery is excluded from formal ethics review.

3. Results

Of the 87 patients included in the analysis, 55 were female. Age ranged from 2 to 80 years (mean age: 38 years), with 19 patients being younger than 18 years. All patients had previously undergone at least one routine EEG, and 27 had undergone either sleep-deprived EEG or EEG under sedation, depending on age (Table 1).

At the time of recording, 29 patients were taking one antiepileptic medication, 21 were taking two, and 8 were taking three or more, whereas 30 patients were not receiving treatment for their possible epilepsy. Medication withdrawal was not undertaken. Duration of video-AEEG was between 24 and 48 h (mean 31 h).

Table 1
Details of previous routine and sleep-deprived or sedation electroencephalography (EEG) findings in the overall study sample (N = 87).

Routine EEG findings	Patients (N = 87)
Normal	59
Nonepileptiform abnormality (e.g., irregular slow waves)	15
Focal epileptiform abnormality	6
Generalized epileptiform abnormality	7
Sleep-deprived/sedation EEG findings	**Patients (N = 27)**
Normal	20
Nonepileptiform abnormality (e.g., irregular slow waves)	3
Focal epileptiform abnormality	2
Generalized epileptiform abnormality	2

Most referrals were motivated by the need for diagnostic clarification (86 studies), in order to determine the nature of paroxysmal events (in 70 patients without a previously established diagnosis) or of newly developed clinical events (in 16 patients with a known diagnosis of epilepsy). Other indications included assessment of seizure frequency and evaluation of possible subclinical seizures in a patient with impaired cognition and a history of nonconvulsive status epilepticus (one study each).

With regard to diagnostic yield, typical clinical events occurred during 55 studies (62.5% of the total number of studies). In 26 of these, at least one event was also clearly seen on video recording. Four studies in which no event occurred contained interictal epileptiform discharges (IEDs), three of which were felt useful in answering the clinical question. In addition, the individual study evaluation of possible subclinical seizures returned clinically relevant negative results. Overall, 59 studies (67.0% of the total number of studies) provided diagnostically useful information.

The clinical events were classified according to three diagnostic categories: epileptic seizures, physiologic nonepileptic events, or PNES [15]. In 6 studies (6.8% of the total number of studies) capturing events, a diagnosis of epileptic seizures was confirmed. The remaining 49 studies capturing events had no associated changes in the underlying AEEG. Diagnosis was reached using information from the referring clinician, medical records, witnessed semiology (if video was available), and description recorded in the patient diary. The results of 13 studies (14.8% of the total number of studies) led to a diagnosis of physiologic nonepileptic events. Types of events and number of studies with successful video recording are detailed in Table 2.

The diagnosis of PNES could be graded as “possible”, “probable”, or “documented” [15], based on the availability of supporting evidence.

Table 2
Types of events occurring during ambulatory electroencephalography (AEEG), including proportions of events recorded on video.

Type of clinical event	N (% of total within group)
Epileptic seizure	6
Recorded on video	2 (33.3%)
Psychogenic nonepileptic seizures	36
“Documented”	14
“Probable”	11
“Possible”	11
Recorded on video	14 (38.9%)
Physiologic nonepileptic events	13
Parasomnia	4
Syncope	3
Migraine	3
Behavioral staring episodes	1
Noncortical myoclonus (drug-induced)	1
Limb-shaking TIA (diagnosis suggested on review of video-EEG and later confirmed after assessment in tertiary center)	1
Recorded on video	10 (76.9%)