Clinical Neurophysiology 128 (2017) 270–274

Contents lists available at ScienceDirect

Clinical Neurophysiology

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

Is long-term electroencephalogram more appropriate than standard electroencephalogram in the elderly?

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A R T I C L E I N F O

Article history:
Received 21 February 2016
Revised 1 October 2016
Accepted 8 October 2016
Available online 27 October 2016

Keywords:
All epilepsy/seizures
Non convulsive seizures
Elderly
Electroencephalogram

H I G H L I G H T S

- Standard EEG has a low diagnostic yield in elderly patients with suspected non-convulsive seizures.
- Long-term EEG was significantly more sensitive than standard EEG in detecting epileptiform discharges.
- Epileptiform discharges were often recorded during sleep only.

A B S T R A C T

Objective: To compare the diagnostic accuracy of standard (st) and long-term video (lt) EEG in elderly patients with suspected non-convulsive seizures.
Methods: Over a 12-month period, we prospectively included all elderly (over-65) hospitalized patients having undergone lt-EEG for suspected non-convulsive seizures ($n = 43$). st-EEG was defined as the first 20 min of each lt-EEG. We recorded the patients' clinical and imaging characteristics and final diagnosis and assessed the respective diagnostic values of st-EEG and lt-EEG.
Results: Epileptiform discharges were detected on standard EEG in only 7% of patients and in 28% of patients on Lt-EEG ($p = 0.004$). Non-convulsive seizures were recorded in 1 case vs. 4, respectively. Nine of 40 negative standard EEG showed later epileptiform activities. The median time to occurrence of the first epileptiform activities was 46.5 min (interquartile range: 36.5–239.75 min). Epileptiform activity occurred during sleep only in 33% patients with a negative st-EEG. Dementia was associated with a positive lt-EEG (p:0.047).
Conclusion: Lt-EEG was clearly superior to standard EEG for detecting epileptiform activity in elderly when suspecting non convulsive seizures.
Significance: St-EEG has a low diagnostic yield in elderly patients with suspected non-convulsive seizures and so lt-EEG is preferable in this situation.

1. Introduction

Epilepsy is frequent in the elderly; the estimated prevalence is 1–2% in people over the age of 60 (Brodie and Kwan, 2005; Hauser et al., 1993) and 7.7% in institutionalized patients over 65 (Garrard et al., 2003). The increasing incidence of epilepsy in the elderly has been linked to the increase in "structural" causes – especially stroke (So et al., 1996) and dementia. However, around 25% of cases are "idiopathic" (Ramsay et al., 2004), which suggests that the brain is predisposed to generate epileptic seizures.

In elderly people, the diagnosis of seizures is often complicated by the fact that the manifestations may be subtle or perplexing (Silveira et al., 2011; Brodie et al., 2009; Oono et al., 2014). Moreover, the patient interview may be complicated by cognitive disorders and the absence of witnesses. Hence, other diagnoses are sometimes considered before epilepsy (Chernyshev et al., 2010;

Abbreviations: EEG, electroencephalogram; st-EEG, standard electroencephalogram; lt-EEG, long-term electroencephalogram; IEDs, interictal epileptiform discharges; MRI, magnetic resonance imaging.

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http://dx.doi.org/10.1016/j.clinph.2016.10.006
1388-2457/

Shavit et al., 2012). However, it is essential to diagnose and treat epilepsy promptly because of the possible complications of seizures and because the over-diagnosis of epilepsy unnecessarily exposes often fragile elderly patients to adverse drug reactions (Besocke et al., 2013). Epilepsy may contribute to the aggravation of dementia, and may predispose stroke patients to dementia (Cordonnier et al., 2007).

EEG seems not to be a very useful diagnostic tool in the elderly. Even if some studies show the same sensibility and sensitivity of EEG in elderly than in younger patients (Watson et al., 2012), most of studies are in favour of lower specificity and sensibility in elderly. Indeed, only 26% of over-60 patients with epilepsy reportedly display interictal epileptiform discharges (IEDs) (Drury and Beydoun, 1998). Hence, EEG's low sensitivity means that the absence of epileptiform abnormalities (i.e. a negative recording) does not rule out a final diagnosis of epilepsy. In view of these findings, Epilepsy Scotland recommends that EEG should not be used to prove or disprove a diagnosis of epilepsy in the elderly (Brodie et al., 2009). Nevertheless, EEG is a cheap, easy-to-use tool. The technique therefore needs to be adapted to address this challenging, important issue in elderly people with suspected non-convulsive seizures.

Some researchers have shown that long term EEG (lt-EEG) could be very helpful to diagnose non-convulsive seizures in the elderly, especially in case of delirium (Naeije et al., 2012, 2014). It has been suggested that lt-EEG is more sensitive than standard EEG (st-EEG) for detecting interictal epileptiform abnormalities. Indeed, we hypothesized that lt-EEG might be a valuable alternative to st-EEG in the elderly (especially to make unlikely a diagnosis of epilepsy). However, literature data on this interesting question are scarce. We therefore performed a prospective, comparative study of the diagnostic value of lt-EEG and st-EEG in elderly people with suspected non-convulsive seizures.

2. Methods

2.1. Inclusion and non-inclusion criteria

Over a 12-month period, we prospectively included all patients meeting the following criteria: aged 65 or over; hospitalization in the Neurology Department at Lille University Hospital (Lille, France); lt-EEG recording requested by the attending physician; and suspected non-convulsive seizures.

The main exclusion criteria were as follows: cancellation of the initial request for lt-EEG prior to recording; excessive agitation; a clear diagnosis after st-EEG (only 1 patient with an EEG displaying a metabolic encephalopathy), making lt-EEG unnecessary.

2.2. Data collection

All EEGs were performed with SystemPLUS® equipment and software (Micromed S.p.A., Mogliano Veneto, Italy), using 19 disc electrodes attached to the scalp (according to the international 10–20 system) with conductive paste, a sampling frequency of 256 Hz, a 0.5–70 Hz band pass filter. All EEG sessions were performed at the bedside in the clinical department.

In the presence of a technician, each recording started with a 20-min period that was subsequently defined as the st-EEG. This included periods of eye-opening and eye-closing, intermittent photic stimulation, hyperventilation, (unless these procedures were ruled out for medical reasons or by the patient's inability or unwillingness to cooperate). The attending medical staff were asked to note all significant events (seizures, paroxysmal neurological events, patient care procedures, etc.)

For each patient, we recorded the gender, age, medical history, current medications, the reason for referral, the time interval between the appearance of suspected non-convulsive seizures and the EEG, the results of the initial clinical examination, the brain imaging results, the presence of any acute disorders (recent stroke, metabolic disorders, infections, etc.), and the final diagnosis. Moreover, when patients were followed up in our hospital, we documented the diagnosis of epilepsy at subsequent visits (up until December 31st 2015).

We classified the reasons for referral into as (i) an altered state or loss of consciousness, (ii) confusion or a behavioural disorder, and (iii) focal neurological signs.

All epilepsy diagnoses were reviewed by a panel of three epileptologists (MC, PD and WS). The final diagnosis was categorized as (i) confirmed epilepsy, with well-documented seizures, (ii) possible epilepsy (i.e. epilepsy remained a potential diagnosis) and (iii) a clearly non-epileptic condition (another aetiology for referral was found, the events occurred during the lt-EEG in the absence of concomitant electric seizures, and/or epileptiform manifestations did not recur during follow-up).

The present non-interventional study was registered with the French National Data Protection Commission (*Commission Nationale de l'Informatique et des Libertés*; reference: DEC2015-117).

2.3. Data analysis

Each st- or lt-EEG recording was assessed by one of three expert neurophysiologists (PD, LT and WS). The neurophysiologist assessed the st-EEG recording and then the lt-EEG recording. The st-EEG and lt-EEG results were classified into four groups:

- A: no focal abnormalities.
- B: slow focal activities.
- C: epileptiform discharges (spikes, spikes-and-waves, polyspikes, polyspikes-and-waves, or sharp waves).
- D: seizures.

If a given patient showed several different types of EEG activities (e.g. both B and D), only the most severe classification (D, in that case) was taken into account. Class A and B results were considered to be "negative". Class C and D results were considered to be "positive". The time to occurrence of the first epileptiform activities (IEDs or seizure) was determined. Lastly, the EEG's overall impact on patient management was evaluated by the medical staff. St- or lt-EEG was considered to be useful if it influenced the patient's management (e.g. by leading to a change in treatment or by confirming or ruling out a diagnosis of epilepsy).

2.4. Statistical analysis

Performance parameters for standard and lt-EEG comparison were compared in McNemar's test. A non-parametric Mann–Whitney U test was used for intergroup comparisons of continuous variables. A chi2 test or Fisher's test was used for intergroup comparisons of categorical variables. The threshold for statistical significance was set to $p < 0.05$.

3. Results

3.1. The study population

Forty-three patients were included (16 men and 27 women; gender ratio: 0.6; mean ± standard deviation (range) age: 82.1 ± 6.59 (68–95)). Twenty-two of the 43 patients (51.2%) had a history of neurological disease; there were 11 cases of dementia