Letter

Spectral Power Changes prior to Psychogenic Non-Epileptic Seizures: a Pilot Study.

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Key words: non-epileptic seizures, EEG

Word count: 992

INTRODUCTION

Psychogenic non-epileptic seizures (PNES) are the most common manifestation of functional (psychogenic) neurological symptoms. Clinically, they consist of intermittent episodes that resemble epileptic seizures and can involve changes in behaviour, movement, sensation, autonomic function or consciousness. To date there are no positive EEG features that have been identified that are diagnostic of PNES and therefore the diagnosis is primarily based on clinical assessment and the absence of epileptic activity during the seizure.

Our goal was to identify a positive marker of PNES, by assessing EEG spectral power changes prior to non-epileptic attacks.

We hypothesized that decreases in beta power (desynchronization in the 13-30 Hz band) might occur prior to a non-epileptic seizure. Beta-desynchronization is known to occur prior to cued movement (event-related desynchronization, ERD) or self-paced movement and was recently shown to occur prior to functional myoclonic jerks [1].

METHODS

Participants

We recruited three patients previously diagnosed with PNES from the Movement Disorder outpatient clinics at the National Hospital for Neurology and Neurosurgery. Three EEG recordings of patients with convulsive epileptic attacks were used as control. The study was approved by the local Ethics Committee and informed consent was obtained.

Procedure

Patients were seated in a comfortable chair while a 32-channel EEG was recorded and a video was made. We asked each subject to sit in a relaxed position with their eyes open and to let attacks happen in their usual way if they occurred. Given the unpredictable nature of the attacks, patients were allowed to talk during the recording period.

Analyses

Data were analysed using Morlet wavelet transformations with Statistical Parametric Mapping (SPM, version 12b). EEG files were epoched to frames from 12 seconds before to 6 seconds after the beginning of attacks. Time frequency analysis was performed using the Multitaper method (SPM default settings). The logRatio method was used to rescale the data and the period of -12s until -10s (relative to the attack) was used as a baseline.

The average power relative to baseline in the beta (13-30 Hz) range over electrodes Cz, C3 and C4 was calculated for the interval starting 12 seconds before and ending at the beginning of the attack. To detect changes in the second range, a moving average method, comprising 20 values, was used for the whole epoch.

RESULTS

Demographics

Patients with PNES were female and aged 43, 59 and 61. A typical PNES attack had a duration of

minutes. Warning before occurrence of an attack was present in two patients (patient 1 sometimes, patient 2 usually) and absent in one. Comorbidity consisted of functional tremor and migraine in patient 1, functional weakness in patient 2 and a combination of migraine and functional weakness in patient 3.

Clinical description

Each patient had a single non-epileptic attack during the EEG recording, which were confirmed by the patients to be typical of their attacks. In patient 1, the event lasted one minute and was characterized by a head drop with closure of her eyes and unresponsiveness with retained perception of sound and touch. Patient 2 had a similar presentation with closure of her eyes and a combination of unresponsiveness and retained perception, but without a head drop, lasting 2 minutes. Patient 3 had generalized rhythmic shaking of all four limbs with eyes closed and loss of perception and responsiveness, lasting 2 minutes. Epileptic seizures were all generalized convulsive.

Spectral power analysis

All three patients with PNES showed a decrease of beta power (desynchronization) prior to their attack, while this was not present in any of the epilepsy patients. Time courses of these individual attacks of the three patients and their mean beta activities are shown for both PNES and epileptic patients in figure 1. The minimum beta power in the peri-ictal interval was found to be around six seconds prior to the attack for patient one. For patient 2 and 3 this value was respectively five and four seconds before attacks. The maximum mean beta desynchronisation

was five seconds prior to the onset of movement.

DISCUSSION

This pilot study suggests that desynchronization of beta power might be a marker of an upcoming non-epileptic attacks. If confirmed in a larger study, it could potentially be a valuable positive marker for PNES. Although all patients confirmed their PNES were typical of their usual attacks, they may theoretically be different as they occurred in a lab setting. A next step would therefore be to analyze attacks during ambulatory EEG recordings. Importantly, we did not see desynchronization prior to a convulsive epileptic attacks, which is consistent with a majority of previously published studies of extracranial EEG in epilepsy patients.

Oscillations in the beta frequency range are the product of synchronisation across populations of neurons. Suppression of beta power occurs prior to cued and self-paced movement and is modulated by attention [2]. It has been proposed that beta activity in the basal ganglia-cortical system provides an internal index of the likelihood of the need for a novel voluntary action, with suppression of beta indicating a higher likelihood [3]. More specifically, changes in beta power prior to movement may index a change in motor attention that promotes a new sensory state at the expense of the current sensory state [4]. If this increase in precision is sufficient, then movement occurs in keeping with the new expected sensory state.

Dissociation, the mechanism suggested to underpin PNES, is often characterized as a loss of attentional focus and resulting dis-integration of emotional and sensorimotor function. However, if beta power suppression prior to the onset of PNES reflects an increase in attention

towards future movement, this is rather at odds with current models of dissociation as the mechanism underlying PNES. Our suggestion of increased attention towards upcoming movements is in line with patient reports of a degree of control over and awareness of an imminent seizure [5].

Therefore, this pilot study provides early evidence for beta oscillations being a potentially useful diagnostic marker of PNES and also challenges current pathological accounts of this common disorder.

COMPETING INTERESTS: none reported

FUNDING: Institutional (Sobell Department of Motor Neuroscience and Movement Disorders, University College London, UCL)

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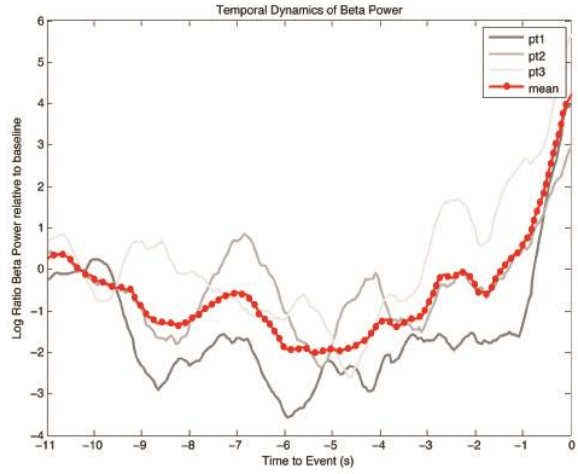
A.



B.

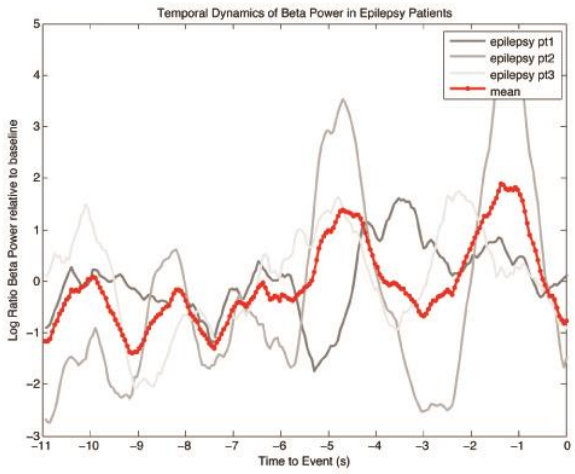


Figure 1: Log Ratio of Beta power in three patients prior to a single non-epileptic seizure and their mean (A) and in three patients prior to an epileptic convulsive seizure (B). The individual data is depicted in the grey lines. The red line depicts the mean beta power of the 3 subjects. The interval from -12 to -10 seconds was used as baseline. Note that in A the sharp increase in power just before the start of the attack is due to movement artifacts.