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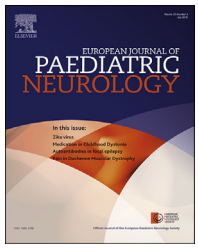

Original Article

Sleep-wake distribution and circadian patterns of epileptic seizures in children

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ABSTRACT

Background: Epilepsy is one of the most common chronic neurologic disorders. Daily periodicity of epileptic seizures has been known for over a century. The diurnal patterns of epileptic seizures have also been observed in studies.
Aim: To investigate the sleep/wake cycle, day/night, and 24-h periodicity of various seizure subtypes and seizure onset localizations in children.
Methods: We analyzed the clinical seizures of 170 consecutive epilepsy patients who underwent video-electroencephalography (EEG) monitoring over the last 5 years. Semiology of the seizures was classified according to the semiological seizure classification. Origin of the seizures was defined by the onset of ictal activity on EEG. Seizures were evaluated in terms of occurrence during the day (06:00–18:00 h) or night (18:00–06:00 h), in wakefulness or in sleep, and within a 3-h time interval throughout 24 h.
Results: A total of 909 seizures were analyzed. Auras, dialeptic, myoclonic, hypomotor, atonic seizures, and epileptic spasms occurred more frequently in wakefulness; tonic, clonic, and hypermotor seizures occurred more frequently in sleep. Auras, dialeptic, and atonic seizures and epileptic spasms occurred more often during daytime; hypermotor seizures occurred more often at night. Generalized seizures were seen most frequently in wakefulness (between 12:00 and 18:00 h); frontal lobe seizures were seen at night and in sleep (between 24:00 and 03:00 h); temporal lobe seizures were seen in wakefulness (between 06:00 and 09:00 h and between 12:00 and 15:00 h); occipital seizures were seen during daytime and in wakefulness (between 09:00 and 12:00 h and between 15:00 and 18:00 h, respectively); parietal seizures were seen mostly during daytime.
Conclusions: Seizures in children occur in specific circadian patterns and in specific sleep/wake distributions depending on seizure onset location and semiology.

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1. Introduction

Epilepsy is one of the most common chronic neurologic disorders. Daily periodicity of epileptic seizures has been known for over a century. In 1885, Gowers[1] observed temporal periodicity for seizure occurrence and classified them as diurnal, nocturnal, and diffuse. Diurnal seizures have a tendency to occur upon awakening and in the late afternoon and nocturnal seizures occur mainly at bedtime and in the morning hours before awakening.[2]

Diurnal patterns of epileptic seizures have also been observed in animal and human studies. Studies in rodents with limbic epilepsy showed that spontaneous seizures were more frequent during exposure to light than during darkness.[3–5]

In human studies, the interaction between sleep and seizure has been studied extensively. Patients with frontal lobe epilepsy typically have seizures arising from sleep,[6,7] especially the lighter stages of non-rapid eye movement (NREM) sleep promote seizure.[8,9] Some studies have focused on the relationship between seizure onset localization and seizure occurrence over a 24-h day. In recent years, studies including children and data about the relationship of seizure semiology to circadian rhythm have also been published. These studies are mostly from the United States and Europe. So we decided to perform a large retrospective study in our tertiary epilepsy center in Ankara, Turkey. More knowledge about the diurnal and sleep/wake pattern of epileptic seizures may help us to understand the pathophysiology of the disease and also predicting the timing of seizure can improve the quality of life of the patients with epilepsy. In our study, all children undergoing video-electroencephalography (EEG) monitoring over a 5-year period were included. Our aim was to evaluate the relationship of sleep-wake and the circadian pattern with various semiologic seizure subtypes and seizure localizations and to compare our results with those of the previous studies.

2. Materials and methods

2.1. Patient selection

For this study, we reviewed the charts of 332 consecutive pediatric epilepsy patients undergoing video-EEG monitoring in our epilepsy center between January 2007 and December 2011. Video-EEG monitoring was performed for classification of epilepsy or presurgical evaluation. Patients with clinicoelectrographic seizures occurring during monitorization were included. One hundred and sixty-two patients were excluded due to non-epileptic recorded events, no recorded events or seizures, and missing data. Thus, a total of 170 patients were included.

Antiepileptic medications were tapered in a manner specific to each patient's condition by taking into consideration the baseline seizure frequency, severity, and history of status epilepticus. Patients were permitted to sleep and wake at their own discretion; however, routine inpatient activities such as physician rounds, nursing care, and meal times may have entrained their schedules. Activity was limited to the patient's room because of the confinement imposed by constant connection to the EEG monitoring system. Patients and parents were instructed to press the seizure alarm during occurrence of clinical seizures or suspicious events.

2.2. Continuous video-EEG monitoring

The duration of continuous video-EEG monitoring varied from 1 to 7 days. Scalp EEG recordings were performed using the 10–20 international system of electrode placement along with bilateral anterior temporal electrodes recorded by Nihon-Kohden Neurofax EEG 1200. A total 23 scalp electrodes and ECG electrodes were placed. Video monitoring was performed by closed circuit video cameras. All EEG and video data were saved and later interpreted by 2 epileptologists. After interpretation, all important clinical information was archived.

2.3. Data analysis

All data including EEG and video was evaluated by a well-trained EEG technician and 2 epileptologists. A total of 909 clinical seizures were analyzed. Subclinical EEG seizures were excluded. To prevent the influence of atypically large seizure counts for a few patients on the overall group distribution, we limited the number of seizures for analysis. Ten seizures per patient were randomly selected. The semiology of seizures was evaluated according to Lüders semiological seizure classification.[10] The first semiologic seizure phase was considered for the analysis when seizures evolved into other clinical seizure types. Retrospectively, time onset of seizure and occurrence in wakefulness or sleep were recorded. Data analysis was based on occurrence of seizures during the day (06:00–18:00 h) or night (18:00–06:00 h), in wakefulness or sleep, and within 3-h time blocks throughout a 24-h cycle. Wakefulness or sleep were assessed regardless of the time of the day. In addition, data were also analyzed based on the localization of the epileptogenic focus. Origin of the seizures was defined by coupling the onset of ictal EEG activity with the semiology of the seizures. When the seizures originated from several lobes based on ictal EEG recordings, they were classified as multilobar category.

2.4. Statistical analysis

The nonparametric binomial test was used to test whether numbers of seizures in day or night and wakefulness or sleep were significantly different. The expected probability is 50%, when assuming that seizures occur randomly. The binomial test compares the observed percentage in the study to the expected percentage. The binomial test can be used when there are only two categories. To analyze the seizure distribution within 3-h time blocks, the 24-h day was divided into 8 bins. The time bins were 00:00–03:00 h (I), 03:00–06:00 h (II), 06:00–09:00 (III), 09:00–12:00 h (IV), 12:00–15:00 h (V), 15:00–18:00 h (VI), 18:00–21:00 h (VII), 21:00–24:00 h (VIII). The non-parametric chi square test was used to test whether numbers of seizures within 3-h time blocks were significantly different. The expected probability is 12.5%, when assuming that seizures occur randomly. The non-parametric chi square test also compares between the observed and the expected