An Evaluation of Serial Postictal EEG Features after Generalized Tonic-Clonic Seizures with Reference to the Interictal Period

Jeneralize Tonik-Klonik Nöbeti İzleyen Postiktal EEG Değişiklikleri ve İnteriktal Dönem EEG Bulguları Açısından Farklılıkları

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Epilepsi 2003;9(1):11-15

Objectives: To evaluate and describe the postictal EEG features after generalized tonic-clonic seizures with reference to interictal EEG.

Patients and Methods: The study included 22 patients who had generalized onset (n=6; 5 males; mean age 27 years; range 11 to 37 years) or partial onset (n=16; 8 females; mean age 22 years; range 12 to 40 years) tonic-clonic seizures. Postictal serial EEG monitoring was performed for 15 consecutive days and an interictal EEG was obtained on the 45th day following the index seizure. The background activity together with asymmetries and epileptiform abnormalities were evaluated.

Results: Fourteen patients with partial onset seizures showed a background slowing or attenuation for a mean of 11.6 days (range 2 to 15 days) and five patients with generalized seizures exhibited a background slowing for 4.5 days (range 2 to 7 days). Hemisphere asymmetry was a striking feature in the partial onset group. Focal and diffuse epileptiform activities were more frequent during the postictal period than those of the interictal EEG.

Conclusion: The postictal period represents both a dynamic course in terms of background activities and a sensitive period for the detection of epileptiform abnormalities. Postictal EEG may be instrumental in patients with new onset epilepsy and in patients with unclassified epilepsy.

Key Words: Electroencephalography; epilepsy/physiopathology; epilepsy, temporal lobe/physiopathology; epilepsies, partial/physiopathology; epilepsy, tonic-clonic; time factors.

Amaç: Jeneralize tonik-klonik nöbeti izleyen postiktal EEG değişikliklerini tanımlamak, bunları interiktal dönem EEG bulguları ile kıyaslamak.

Hastalar ve Yöntemler: Parsiyel (n=16; 8 kadın; ort. yaş 22; dağılım 12-40) veya jeneralize (n=6; 5 erkek; ort. yaş 27; dağılım 11-37) başlangıçlı tonik-klonik nöbet geçiren 22 hastada 15 gün boyunca rutin EEG incelemesi yapıldı. Bu süre postiktal dönem olarak kabul edildi; indeks nöbeti izleyen 45. günde çekilen EEG de interiktal olarak kabul edildi. Postiktal dönemdeki temel biyoelektrik aktivitedeki değişiklikler ve epileptiform anomaliler interiktal dönemle kıyaslanarak incelendi.

Sonuçlar: EEG'de temel aktivite yavaşlaması, parsiyel başlangıçlı nöbet geçiren olguların 14'ünde ortalama 11.6 gün (dağılım 2-15 gün) süreyle; jeneralize grupta beş hastada ortalama 4.5 gün (dağılım 2-7 gün) süreyle izlendi. Parsiyel grupta hemisfer asimetrisi çarpıcı bir bulgu olarak gözlendi. Postiktal dönemdeki epileptiform aktivitelerin her iki grupta da interiktal döneme göre daha yoğun olduğu görüldü.

Sonuç: Postiktal dönem, temel aktivite değişikleri ve epileptiform aktiviteleri görebilmek açısından dinamik ve duyarlı bir dönemdir. Postiktal dönem EEG bulgularının, ilk nöbetini geçiren ve sınıflandırılamayan epilepsi hastalarında yararlı bilgi sağlayabileceğini düşünüyoruz.

Anahtar Sözcükler: Elektroensefalografi; epilepsi/fizyopatoloji; epilepsi, temporal lob/fizyopatoloji; epilepsi, parsiyel/fizyopatoloji; epilepsi, tonik-klonik; zaman faktörleri.

Received: November 2, 2002 Request for revision: December 8, 2002 Accepted for publication: December 12, 2002

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The role of EEG in the evaluation of seizure disorders is usually limited to interictal and ictal periods. EEG descriptions of the postictal period refer mainly to the initial postictal period. The early postictal period of tonic-clonic seizures is usually characterized by homogeneous changes such as a diffuse attenuation followed by a generalized slowing of the background activity.[1,2] Initial interictal EEG recordings may not present any abnormality in nearly 50% of epileptic patients.[3] In contrast, late postictal recordings of tonic-clonic seizures may reflect progressive changes until the interictal, baseline EEG features restore, and thus, be more informative.

This study was designed to evaluate the EEG features of the late postictal period in comparison with those obtained from interictal recordings and to find out the time needed for the EEG to return to its baseline, interictal level.

PATIENTS AND METHODS

Patient selection

Twenty-two patients who had generalized onset (n=6; 5 males; mean age 27 years; range 11 to 37 years) or partial onset (n=16; 8 females; mean age 22 years; range 12 to 40 years) tonic-clonic seizures were admitted to our emergency room during a 10-month period. Patients whose seizures were associated with a progressive disease or induced by a provocative cause were excluded. Recurrence of a grand mal seizure during the study period was regarded as an exclusion criterion, as well. The seizures were classified according to the system proposed by ILAE (1981).[4] Informed consent was obtained from all patients or their family members.

Study protocol

The time interval between a single seizure and the initial EEG recording was arbitrarily designed to be not more than eight hours. Serial EEG recordings were performed for fifteen consecutive days, which was designated as the postictal period (PP). In cases in which restoration of the background activity was not observed on the 15th day, the length of PP monitoring was extended by a seven-day period. On the 45th day, a final EEG recording was obtained as a reference for the interictal period (IP). All EEG recordings were standardized to be performed for an initial 15-minute baseline followed by hyperventilation and photic stimulation for three minutes with the use of the international 10-20 montage system on an eight-channel analogue Nihon Kohden EEG device.

Data analysis

At the end of all serial EEG recordings, each EEG test was analyzed by two EEG experts, one of whom was blinded to the clinical data of the patients. The criteria used in the evaluation of EEGs were strictly defined under the guidance of the observations from 10 patients previously investigated. Each patient was evaluated with respect to possible dynamic changes during PP and with reference to IP features. EEG activity observed during hyperventilation and photic stimulation was not included in the analysis of the data.

Criteria used for EEG analyses

Background activity:

Alpha-waves: Diffuse slowing or attenuation of the background activity was associated with gradually predominating alpha-waves that were initially intermingled with theta or delta activities. These waves of short duration were defined as alpha-paroxysms, the appearance of which was interpreted as the initial phase of restoration of the background activity. Sinusoidal, continuous, and consistent alpha-waves appearing as a dominant feature of the EEG activity were regarded as complete restoration of the normal background activity. This normalization was not observed in all cases due to persistent interictal slowing.

Asymmetry of the background activity: Any asymmetry in the frequency and/or amplitude of the background activity in a hemisphere was another parameter used. Some EEGs exhibited a regional slowing regardless of the hemispheric asymmetry. This feature was designated as regional slowing. Some EEGs showed both a hemispheric asymmetry and a more pronounced regional slowing in that hemisphere. The time at which these asymmetries were observed and disappeared during PP was also noted.

Epileptiform abnormalities: Focal sharp and spike-waves and a diffuse epileptiform activity were observed on each EEG during PP and IP

and the extent of epileptiform activities between these two periods were compared.

RESULTS

Partial onset tonic-clonic seizures

The mean age at the onset of disease was 16 years (range 2 to 34 years). The mean duration of epilepsy was 5.7 years (range 1 month to 22 years). Of sixteen patients, seven were considered having intractable epilepsy, one patient had new-onset epilepsy; in others, seizures were associated with drug withdrawal. Computed tomography and/or magnetic resonance imaging studies suggested that four patients had remote symptomatic epilepsy; others were identified as cryptogenic epilepsy.

On the first PP day, EEG showed a diffuse generalized background slowing in 12 patients, diffuse attenuation in two patients, and a normal background activity in two patients. Alpha paroxysms were observed in a mean period of 5.4 days (range 1 to 5 days).

Restoration of the normal background activity occurred in 12 patients within a mean period of 11.6 days (range 2 to 15 days). It was followed by an increase in alpha frequency by 1 Hz.

Hemispheric asymmetry observed in the background activity in eight patients disappeared within a mean of five days (range 3 to 15 days) during PP.

There was a regional background slowing in seven patients during PP, which still maintained on IP recordings in two patients. This regional slowing was observed for a mean of 11 days (range 8 to 15 days).

Focal epileptiform activity identified in twelve patients during PP did not disappear in four patients during IP. Focal sharp activities disappeared in a mean of eight days (range 8 to 11 days) in eight patients. Paroxysmal epileptiform activity was recognized in four patients during PP and disappeared in a mean of 10 days in three patients.

Generalized onset tonic-clonic seizures

The mean age at the onset of disease was 17 years (range 6 to 20 years). The mean duration of the disease was nine years (range 1 month to 20 years). Of six patients, one patient had new-onset epilepsy; two patients developed seizure recurrence despite monotherapy less than a month before the study; three patients had seizures after withdrawal of their medication.

On the first PP day, slowing of the background activity was present in all patients but one, and alpha paroxysms were observed in all patients. The restoration of the normal background activity occurred in all patients in a mean of 4.5 days (range 2 to 7 days). None of the patients exhibited hemispheric asymmetry or regional slowing.

Focal sharp activity was detected in one patient throughout the first seven PP days, with migration in both hemispheres without a clear localization. Paroxysmal activities were observed in all patients for about nine days during PP. One patient maintained this activity during IP.

DISCUSSION

Generally, an initial interictal EEG reveals epileptiform abnormalities in 29% to 55% of patients.[5] Postictal EEG may add further data about these abnormalities; however, its use is uncommon in epilepsy practice. To our knowledge, a structured study does not exist to define the features of PP after generalized tonic-clonic seizures. In this study, we evaluated the features of this period with reference to those of the interictal period.

Our study does have some limitations. The findings would have been much more sensitive if a digital EEG device had been used instead of an eight-channel analogue device. Similarly, the frequencies of both background and epileptiform activities could have been statistically comparable. As a consequence of these limitations, the results only reflect observations on the presence or absence of the findings designed for search criteria.

The duration of the PP on EEG after a tonic-clonic seizure was about 10 days in the partial onset group, and five days in the generalized onset group.

Alpha paroxysms were accepted as the earliest sign of restoration of the normal background activity in this study. This feature was almost invariably observed on the first day in the generalized onset group, whereas early

background reversion occurred only in 42% in the partial onset group.

Serial EEG tests performed after a tonic-clonic seizure may be of help in the classification seizures as early reversion of the background activity may be linked to generalized epilepsies. Kaibara and Blume[6] reported that early reversion to the interictal period was found in 31% of their patients. In addition, it was observed mostly in patients who were lacking in propagation. Compared to the above-mentioned study in patients who mostly had simple partial or complex partial seizures, we noted a notable prolongation in the postictal period, which suggests that propagation of a seizure affects the duration of the postictal period. Nevertheless, as far as the duration of the restoration of PP is concerned, this observation does not account for the difference between the partial and generalized onset patients. Further studies are required to clarify this difference.

With the exception of four patients with persistent interictal slowing in the partial onset group, all EEG's demonstrated an increase in the alpha frequency by one Hz after restoration of the normal background activity. This postictal feature was first mentioned by Fisch.[7] The increase in alpha frequency throughout PP may prove to be helpful in identifying patients who are suspected of having tonic-clonic-like pseudo-seizures.

It seems that hemisphere asymmetry is one of the most striking features during PP in partial onset patients, as this finding was not observed at all in generalized onset patients. More interestingly, in none of the patients was this feature present during IP, suggesting the high sensitivity of background asymmetries in the postictal period.

An early postictal EEG in the first week of a seizure may help to distinguish its focal onset nature. Of sixteen partial onset patients, focal sharp and spike activities were noted in 75%; however, this feature did not persist on IP recordings after a mean of eight days in eight patients. Thus, the postictal period seems to be associated with an increase in spike activities followed by a decrease in frequency, and ultimately, a dissipation. A similar observation concerning a 25% increase in postictal spike frequency was reported by Kaibara and Blume.[6] Postictal increases in spike activities are related to extracellular levels of potassium and calcium, which are found to be excessive and lacking, respectively. There is controversy as to whether increased postictal spike activities are correleted with the side of seizures. While Kaibara and Blume[6] reported correspondence between the two, Gotman and Koffler[8] concluded that postictal spike activities did not necessarily reflect the site of the seizures. An electrocorticogram study by Hufnagel et al.[9] demonstrated, in patients with medically intractable epilepsy, that the postictal slow focus was related with the epileptogenic zone in 85%, especially in patients with temporal lobe seizures. Data from the above-mentioned studies suggest a high sensitivity of postictal period monitoring in the detection of epileptiform abnormalities, but the value of scalp EEG in predicting localization has yet to be elucidated.

There are SPECT and PET studies evaluating the value of postictal period for localization of temporal or extratemporal lobe epilepsies.[10-12] In a study of complex partial seizures, it has been demonstrated that both ictal and postictal SPECT findings were in correlation with EEG and magnetic resonance imaging.[13]

One patient had focal sharp activities during PP in the generalized onset group. We noted that they had no consistent localization and migrated between both hemispheres. Intermittent interictal spikes, polyspikes and sharp waves may occur in generalized epilepsies sporadically as rudiments of interictal paroxysms.[7] Sporadic interictal focal activities may be a postictal feature of generalized seizures, indicating a change in excitability of the cortex after seizures.

Postictal EEG seems to be valuable in detecting paroxysmal abnormalities in generalized onset patients because they were manifest in all the patients during PP, but in only one patient during IP, who had a new onset seizure without medication. This may be an interesting finding with regard to paroxysmal abnormalities, suggesting suppressive action of antiepileptic drugs.

In conclusion, the postictal period represents both a dynamic course in terms of back-

ground activities and a sensitive period for the detection of epileptiform abnormalities.

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