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Brief Communication

Clinical Significance of EEG Abnormalities During Photic Stimulation in Patients with Photosensitive Epilepsy

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Summary: *Purpose:* The continued presence of EEG abnormalities in patients with a history of photosensitive seizures is used to signify the persistence of photosensitive epilepsy. The extent to which this approach places patients at risk of seizures is unclear, however. We describe those EEG abnormalities that may be tolerated with low risk of further seizures, and those that are indicative of poor seizure control.

Methods: Fifty patients with EEG evidence of persistent photosensitive epilepsy underwent photosensitivity testing with diffuse and patterned light; 58% of patients continued to experience seizures, and 42% were seizure free. The incidence of EEG abnormalities to diffuse and patterned intermittent photic stimulation (IPS) was analysed as a function of recent seizures.

Results: All patients showed EEG abnormalities to patterned IPS; there was no significant association between patterned IPS and poor seizure control. EEG abnormalities to diffuse IPS occurred in 58% of patients, and 76% of these patients had experienced a seizure within the previous year. These patients were more than twice as likely to be poorly controlled than those who showed abnormalities only to patterned IPS. These results were consistent for both medicated and unmedicated patients.

Conclusions: EEG abnormalities to patterned IPS can be used to signify the persistence of photosensitive epilepsy, but abnormalities to diffuse IPS are more likely to indicate the patient is poorly controlled and at risk of further seizures. **Key Words:** Photosensitive—Epilepsy—Clinical—EEG—Seizures.

Photosensitive epilepsy is characterised by a history of seizures elicited by flashing or flickering lights and, during EEG testing, by the presence of photoparoxysmal responses (PPRs) on intermittent photic stimulation (IPS). The disorder manifests most commonly around the age of 7 to 19 (1) and is estimated to occur in 0.025% of the population (2). This figure, however, may be a conservative estimate of the prevalence of photosensitivity, as not all individuals with the potential to display seizures in response to visual stimulation will be exposed to the required stimulus; this was demonstrated recently in Japan when 685 children and adults reported symptoms presumed to be seizures while watching a cartoon containing rapid colour changes (3). During EEG testing for photosensitivity, both diffuse (unpatterned) and patterned IPS are used, as not all patients with a clinical history suggestive of photosensitivity demonstrate EEG abnormalities to diffuse flash, but do so in response to patterned IPS (2). An example of the line grid used to generate patterned IPS is shown in Fig. 1. Patterned light appears, therefore, to be a more epileptogenic stimulus than diffuse light.

Photosensitivity remits spontaneously during the second decade of life in 25% of patients (4), although at present there is no method of predicting which patients will do so. Many clinicians therefore prescribe anticonvulsant medication at a dose sufficient to prevent the occurrence of seizures, but not to abolish all abnormalities from the EEG (2). In addition to the decreased likelihood of drug toxicity (5), this approach makes use of the continued presence of EEG abnormalities as an indicator of the persistence of photosensitivity; the disappearance of abnormalities suggests that the patient may have gone into remission. Although this method reduces the probability of unnecessary continuation of medication, and of the patient being labeled unnecessarily as having epilepsy, such an approach can be considered ethical only if it does not place the patient at risk of experiencing further seizures. There is a requirement, therefore, to identify those EEG abnormalities that may remain present when the patient is sufficiently well controlled, and those that indicate that the patient is at risk of experiencing seizures.

This study aimed to investigate the clinical significance of EEG abnormalities elicited during patterned and

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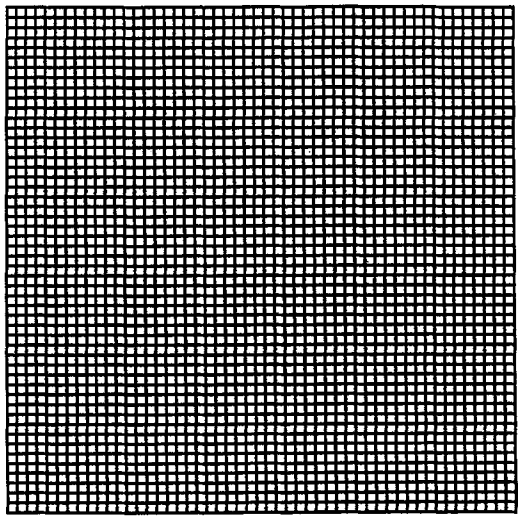

FIG. 1. The line grid used to generate patterned intermittent photic stimulation: the grid, or quadrille, is superimposed on the lamp, producing a flashed-on pattern. See reference 2 for further details.

diffuse IPS in a group of patients with photosensitive epilepsy and to determine those EEG abnormalities that indicate that the patient is highly photosensitive and at risk of experiencing seizures. It is hypothesised that because patterned IPS represents a highly epileptogenic visual stimulus, the presence of PPRs during patterned IPS may not be predictive of poor seizure control and can be used as an indicator of persistent photosensitivity. In contrast, PPRs observed in response to diffuse IPS may be more indicative of poor control and suggest that the patient may be at risk of further seizures. If this hypothesis is supported, the clinician may be better able to determine those EEG abnormalities that may be tolerated as a continuing indicator of the persistence of photosensitivity and those that are indicative of poor seizure control.

METHODS

Participants

Fifty patients with a history of photosensitive epilepsy and EEG evidence of photosensitivity were included in the study. Both clinical and electrophysiologic evidence of photosensitivity were required, as it was necessary to ensure that all patients had photosensitive epilepsy at the time of EEG testing. Seventeen were male and 33 were female patients; the mean age was 24, ranging from 6 to 55 years. Thirty-three patients were medicated, 18 with sodium valproate (VPA), nine with lamotrigine (LTG), and six with carbamazepine (CBZ).

Patient history

Patients were questioned about their seizure history and were classified as (a) still experiencing seizures, or (b) seizure free. To be classified as seizure free at the time of the EEG, patients must have been without seizures $\geq$1 year. Twenty-nine (58%) patients continued to experience seizures, whereas 21 (52%) were seizure free. There was a small but significant age difference between those experiencing seizures, mean age 21 years, and those who were seizure free, mean age, 28 years [t (df = 48, two-tailed) = 2.66, p = 0.01]. There was no significant difference in the incidence of seizures in medicated and unmedicated patients [χ^2 (1 df, two-tailed) = 1.13, p = 0.26].

Procedure

EEG activity was recorded from 19 scalp positions, corresponding to the International 10-20 system, by using a Nihon Khoden EEG machine. Photic testing was performed according to our standard protocol (2), by using a Grass PS22 photostimulator at a distance of 30 cm from the patient's eyes, according to international recommendations (D. G. A. Kasteleijn-Nolst Trenité et al., unpublished observations). The lamp subtended 25 degrees, and the luminance was 1,363 cd/m (68 cd/s/m). Flash frequencies between 1 and 60 Hz were tested both with (patterned IPS) and without (unpatterned, or diffuse IPS) the presence of a line grid. The presence of EEG abnormalities [both PPRs and degraded (postcentral) PPRs] was noted for each stimulus condition. The presence of occipital spikes was ignored.

RESULTS

All patients included in the study had EEG abnormalities on IPS. The occurrence of recent photosensitive seizures was examined as a function of EEG abnormalities to diffuse and patterned IPS. Abnormalities to patterned IPS occurred in all patients; there was therefore no significant association between observed abnormalities to patterned IPS and recent seizures. Abnormalities to diffuse IPS were less common than to patterned IPS, occurring in 29 (58%) of patients. The incidence of recent seizures as a function of EEG abnormalities to diffuse IPS is shown in Fig. 2: of patients with recent seizures, 22 (76%) showed abnormalities to diffuse IPS, whereas seven (24%) did not. Of patients who were seizure free, seven (33%) showed abnormalities to diffuse IPS, whereas 14 (67%) did not. These results demonstrate that patients with abnormalities to diffuse IPS were significantly more likely to have recently experienced a seizure than were those who showed abnormalities only to patterned IPS [χ^2 (df = 1, two-tailed) = 9.04, p = 0.003].

The results were examined separately for unmedicated patients and for those taking anticonvulsants (AEDs). There is a significant association between EEG abnor-

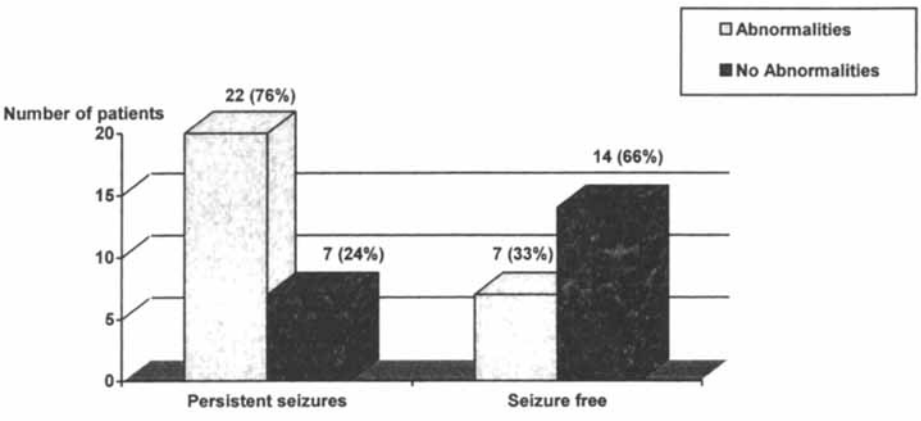

FIG. 2. The incidence of EEG abnormalities in response to diffuse (unpatterned) intermittent photic stimulation (IPS) in patients with photosensitive epilepsy who have persistent seizures, or who are seizure free. Note that the majority of patients (76%) with persistent seizures have EEG abnormalities to diffuse IPS, whereas a minority of patients (33%) who are seizure free show similar EEG abnormalities.

malities to diffuse IPS and persistent seizures in both medicated [χ^2 (df = 1, one-tailed) = 2.83, p = 0.046] and unmedicated [χ^2 (df = 1, one-tailed) = 4.97, p = 0.01] patients. Although there are insufficient numbers of patients prescribed different medications to allow statistical testing for each group separately, the trend holds for each individual group.

DISCUSSION

The presence of EEG abnormalities during IPS is a useful indicator of the persistence of photosensitivity. The clinician must decide, however, when these abnormalities also indicate that the patient is not sufficiently controlled and is therefore at risk of experiencing further seizures. This study related the incidence of EEG abnormalities during IPS to patients' reports of recent seizures. The results demonstrate that abnormalities to patterned IPS are more common than those to diffuse IPS and, although consistent with the clinical history of photosensitivity, are not a reliable predictor of the patient's being poorly controlled: of those patients displaying EEG abnormalities only to patterned IPS, 33% experienced a seizure within the previous year, and 67% were seizure free. Abnormalities to diffuse IPS are, however, significantly associated with current seizures: 76% of patients who show such abnormalities experienced seizures, and 24% were seizure free.

These results suggest a continuum of photosensitivity, with those patients who show abnormalities to diffuse light being significantly more likely to experience seizures than those patients who show abnormalities only to patterned light. It cannot be assumed, however, that this latter group of patients is not at risk of further seizures, as a third of this group had experienced a seizure within the previous year. Similarly, not all patients who show abnormalities to diffuse light are poorly controlled, as a quarter were seizure free at the time of the EEG. This may, however, be due to patients' avoiding provocative stimuli: our patients undergo comprehensive photic and pattern testing and are advised of visual stimuli and viewing conditions that present a high risk of seizures. Such an avoidance strategy may also explain why those patients who are seizure free are more likely to be older than those still experiencing seizures: as photosensitive epilepsy manifests most commonly around puberty, the older patients are likely to be more experienced at avoiding provocative stimuli. Furthermore, effective avoidance strategies may contribute to the lack of significant difference in seizure incidence between medicated and unmedicated patients.

The results described here demonstrate a rapid assessment of the patient's degree of photosensitivity, and are of significance to clinicians deciding whether a patient is suitably controlled. Abnormalities that occur in response to patterned IPS, particularly those that occur over a limited range of frequencies, may not indicate that the patient is poorly controlled and at risk of further seizures. Those abnormalities that occur in response to diffuse IPS, however, do suggest that the patient is at risk of experiencing further seizures. These patients are more than twice as likely to experience seizures than are patients who show abnormalities only to patterned IPS.

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