Photosensitive Epilepsy

Intermittent photic stimulation (IPS) may produce epileptiform discharges and seizures, most of which are generalized. There are several cases of focal seizures of occipital origin induced by IPS and only five reported cases originating from the temporal lobe (TL) in 2003 [1)].

Light flashes, patterns, or color changes can provoke seizures in up to 1 in 4000 persons. Prevalence may be higher because of selection bias. The Epilepsy Foundation reviewed light-induced seizures in 2005. Since then, images on social media, virtual reality, three-dimensional (3D) movies, and the Internet have proliferated. Hundreds of studies have explored the mechanisms and presentations of photosensitive epilepsys, justifying an updated review. This literature summary derives from a nonsystematic literature review via PubMed using the terms “photosensitive” and “epilepsy.” The photoparoxysmal response (PPR) is an electroencephalography (EEG) phenomenon, and photosensitive seizures (PS) are seizures provoked by visual stimulation. Photosensitivity is more common in the young and in specific forms of generalized epilepsy. PS can coexist with spontaneous seizures. PS is hereditable and linked to recently identified genes. Brain imaging usually is normal, but special studies imaging white matter tracts demonstrate abnormal connectivity. The occipital cortex and connected regions are hyperexcitable in subjects with light-provoked seizures. Mechanisms remain unclear. Video games, social media clips, occasional movies, and natural stimuli can provoke PS. Virtual reality and 3D images so far appear benign unless they contain specific provocative content, for example, flashes. Images with flashes brighter than 20 candelas/m2 at 3-60 (particularly 15-20) Hz occupying at least 10 to 25% of the visual field are a risk, as are red color flashes or oscillating stripes. Equipment to assay for these characteristics is probably underutilized. Prevention of seizures includes avoiding provocative stimuli, covering one eye, wearing dark glasses, sitting at least two meters from screens, reducing contrast, and taking certain antiepileptic drugs. Measurement of PPR suppression in a photosensitivity model can screen putative antiseizure drugs. Some countries regulate media to reduce risk. Visually-induced seizures remain significant public health hazards so they warrant ongoing scientific and regulatory efforts and public education [2)].

Elmalı et al. aimed to investigate the modulation of epileptiform discharges in patients with mesial temporal lobe epilepsy associated with hippocampal sclerosis (MTLE-HS) via photic stimulation (PS), based on a hypothesis that light stimulation may activate thalamocortical networks limiting the propagation of interictal epileptiform discharges. In order to do so, all EEGs performed in patients diagnosed with MTLE-HS were reviewed to include available recordings with definite epileptiform abnormalities. These were reevaluated by two clinical neurophysiologists independently, and spikes were counted in a blinded manner to calculate spike index (SI) (spikes per minute-pm) for baseline EEG, hyperventilation (HV), and PS periods. Our final study group consisted of 30 MTLE-HS patients with a mean age of 34.5 (±12.5) years. Mean seizure frequency was 38.1 per year (±46.6), and the mean disease duration was 16.2 years (±12.1). Mean SI during baseline was calculated as 1.17 pm (±1.4), during HV 2.1 pm (±2.8) and during PS 0.8 pm (±2.5). As a result, SI was significantly lower during PS compared to baseline ($p = 0.001$). The findings suggest that PS has a remarkable inhibitory effect on epileptiform discharges in MTLE-HS patients, indicating the need for further prospective investigations for clinical translation [3)].

In clinical practice, there is a prevailing notion that photosensitivity mostly occurs in children with

epilepsy (CWE) with idiopathic generalized epilepsy.

van Win et al. investigated the distribution of epilepsy types and etiology in photosensitive children and the associations with specific clinical and electroencephalogram (EEG) variables.

In this retrospective cohort study, clinical data were acquired from all children that showed photosensitivity during systematic intermittent photic stimulation (IPS), over a 10-year interval at a tertiary level Children's Hospital, Winnipeg. Patient demographics, EEG findings, and clinical data and symptoms during IPS were abstracted. Classification of diagnoses using the International League Against Epilepsy (ILAE) 2017 guidelines was done by an expert panel.

Seventy-eight photosensitive children were identified. Forty (51.3%) had generalized epilepsy (idiopathic: 27, structural: 2, other: 11) compared with 19 (24.4%) focal (idiopathic: 1, structural: 2, other: 16), 8 (10.3%) combined focal and generalized (structural: 4, other: 4), and 11 (14.1%) unknown epilepsy (other: 11); ($\chi 2$ (3) = 32.1, p = .000). Self-sustaining or outlasting photo paroxysmal responses (PPRs) occurred in association with all epilepsy types; however, the EEGs of focal CWE without treatment comprised almost solely of PPRs which outlasted the stimulus (8/10), in contrast to only 8/17 of focal CWE with treatment and to 13/26 of generalized epilepsy without treatment. Most frequency intervals in individual patients were less under treatment: a decrease in standardized photosensitivity range (SPR) was seen in 5 CWE, an increase in 2, and no change in 1 during treatment. Both CWE with focal and generalized epilepsy showed abnormal activity on EEG during hyperventilation (40% vs 65.7%). Thirteen out of 14 CWE with clinical signs during IPS had independent spontaneous epileptiform discharges (SEDs) in the EEG recording.

Photosensitivity occurs in all types of epilepsy rather than in idiopathic generalized epilepsy alone. Surprisingly, there is a tendency for focal epilepsy to be associated with self-sustaining PPRs, especially when no treatment is used. Treatment tends to make the PPR more self-limiting and decrease the SPR. There is a tendency that clinical signs during IPS occur in EEGs in individuals with SEDs [4].

Quirk et al. undertook a prospective nationwide study to determine the incidence of photosensitive epilepsy (PE). Virtually all EEG departments in Great Britain (providing approximately 90% coverage of all EEGs performed on people with newly diagnosed seizures) screened cases referred to them over a 3 month period and identified all new cases of epilepsy (defined as one or more recognized seizures) whose first EEG showed a photoparoxysmal response (PPR) on intermittent photic stimulation (IPS). 191 cases were identified, 143 of whom had type 4 PPRs (generalized spike and wave on IPS) on their first EEG. The annual incidence of cases of epilepsy with type 4 PPRs on their first EEG was conservatively estimated to be 1.1 per 100,000, representing approximately 2% of all new cases of epilepsy. When restricted to the age range 7-19 years, the annual incidence rose to 5.7 per 100,000-approximately 10% of all new cases of epilepsy presenting in this age range. To ascertain if there was a significant seasonal variation in PE, 5 EEG departments (which together contributed 15% of cases in the first study period) were visited during a second 3 month study period to identify all new cases of epilepsy with type 4 PPRs on their first EEG. No significant seasonal variation in incidence between summer and winter was found [5].

Prevention

Using Z1 lenses results in neither a complete PPR disappearance nor a complete lack of effect.

However, the correlation between the quantified PS suppression and the Z1 filter may be expected to become a valuable piece of information for both clinicians and manufacturers [6].

1)
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