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Photic stimulation during electroencephalography: Efficacy and safety in an unselected cohort of patients referred to UK neurophysiology departments

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ABSTRACT

Purpose: To determine efficacy and safety of photic stimulation (PS) during electroencephalography (EEG) in a large group of adult and paediatric patients.
Methods: A prospective multicentre National Service Evaluation was performed organised by the joint audit committee of the two UK professional organisations (Association of Neurophysiological Scientists and British Society for Clinical Neurophysiology). Questionnaires about every EEG performed in the two-month study period were completed contemporaneously by physiologists at the time of the recording-reporting. The occurrence during PS of photoparoxysmal responses (PPRs), seizures and psychogenic non-epileptic attacks was noted from the EEG trace and contemporary clinical observation backed up by the video that was synchronised with the EEG. 5383 patients investigated with EEG and PS, mostly for possible epilepsy, were included in the study.
Results: Seventy nine patients (1.5%) had a generalised PPR elicited by PS having had no generalised epileptiform discharges previously in the EEG. Thirty nine patients (0.7%) had seizures provoked by PS including two (0.04%) who had a generalised tonic clonic seizure (GTCS). Forty nine patients (0.9%) had non-epileptic attacks provoked by PS. Thus PS yielded potentially useful information (PPRs, seizures or non-epileptic attacks) in 167/5383 (3.1%) of patients. In a subset of 122/5383 (2.3%), PS provided the only useful information captured within the EEG.
Conclusion: PS contributes to the diagnosis of epilepsy and non-epileptic attack disorder in 3.1% of patients. It is a safe technique which produces GTCSs in only 0.04% patients. We conclude that PS is a moderately useful activation technique in diagnostic EEG, where the potential benefits out-weigh the risks; this information may assist the informed consent process.

1. Introduction

Photic stimulation (PS) is widely used in routine video-EEG and can contribute to the management of patients suspected of having epilepsy. It may aid the diagnosis of epilepsy, support and refute specific epileptic syndromes, help predict the likelihood of seizure recurrence and allow the referring physician to counsel the patient on environmental factors that might provoke photosensitive seizures. Useful information can be provided in two ways, first by provoking epileptiform discharges referred to by convention as photoparoxysmal responses (PPRs) and second, it may trigger epileptic seizures and psychogenic non-epileptic attacks (NEAs). The aim is to gain electrographic data without triggering generalised tonic clonic seizures (GTCSs) because of the associated risks to the patient.

The GMC consent guidance [1] emphasises the need for patients to be properly informed prior to consenting to clinical procedures. Because PS is a common procedure and because it is recommended as part of a standard EEG [2–4] it is important to quantify as far as is practicable the risks and potential benefits (safety and efficacy) of

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the EEG and PS in order to inform the patient or their proxy prior to their giving or withholding consent. In this case the main risks are precipitating seizures and the main benefits accrue from diagnostic information. Unfortunately, data from large-scale series about safety and efficacy are sparse. In 20,000 cases collected over eleven years [5] PPRs were reported in 225 cases un-associated with accompanying "convulsions" and in a further 25 cases "convulsions" were induced by PS. In a more recent retrospective series five cases of myoclonic jerks and one of dizziness and distress from 732 undergoing PS were reported [6].

The current National Service Evaluation described in this paper was designed to determine the efficacy of PS in producing diagnostically useful data, and provide data on the safety of the procedure from a large, national population of adult and paediatric patients. The participating bodies (Association of Neurological Scientists and British Society for Clinical Neurophysiology) represent professionals providing EEG services in every major department in the UK.

2. Methods

Eighty three departments were invited to participate in the study (see Appendix A). Sixty eight (82%) departments responded. Questionnaires (see Appendix B) were completed for all adult and paediatric patients attending for routine (not sleep-deprived) EEG between the 1st November and 31st December 2013 inclusive so that there was no selection bias in the questionnaires returned for analysis. Sleep-deprived recordings were not included because sleep deprivation has a facilitating effect on PPRs [7] and can be considered an activation technique in its own right.

Questionnaires were completed by the recording clinical physiologist at the time of the EEG and registered details about each patient, including their referral diagnosis and whether PS was performed. As can be seen from the questionnaire (Appendix B), detailed Information about the PS procedure, the make, model and characteristics of the photic stimulators used was not collected.

Referral diagnoses other than epilepsy or non-epileptic attack disorder (NEAD) such as neurodegenerative diseases could be captured on the questionnaire.

In the case of NEAD, the questionnaire did not record whether or not the referring doctor requested an attempt to elicit a NEA.

If PS was not performed, physiologists were required to specify a reason. Exclusions such as 'too old' were based on local protocols that have been separately surveyed [8].

Physiologists registered a 'Yes' or 'No' if a PPR (without discernible clinical changes) occurred. The cases with discernible clinical changes associated with PS were classified by the physiologist at the time of the video-EEG as either a seizure or a NEA. For the purposes of the study, we broadly defined seizures as clinical neurological events with an EEG correlate, even if brief (e.g. myoclonic jerks). These were subsequently further subdivided as far as was practicable into seizure types. NEAs were not subdivided into semiological categories.

With regard to electrographic events produced by PS, the questionnaire was designed to identify specified electrographic changes i.e. "unequivocal generalised epileptiform interictal EEG activity (i.e. a Type III or IV photoparoxysmal response) NOT seen in the resting record." All references to a PPR in this paper describe instances of Waltz et al. [9] Type III/IV. The higher grade response, particularly grade IV, is associated with a greater tendency towards seizures [10–12].

Information on the specific PS protocol was not collected. The data were analysed using Microsoft Access and Excel and IBM SPSS version 19.

Table 1
Demographic data.

	Photic Stimulation	No Photic Stimulation
Demographic data from 6807 patients undergoing routine EEG		
Number of patients	5383	1424
Mean age in years (range)	30 (<1–99)	45 (<1–99)
% Sex F:M	49:51	48:52
No. (%) taking AEDs	1353 (25%)	266 (19%)
Referral diagnosis from 6807 patients undergoing routine EEG[a]		
Epilepsy	4420 (82%)	1054 (74%)
NEAD	133 (3%)	22 (4%)
Epilepsy and/or NEAD	258 (5%)	60 (2%)
Other	560 (10%)	283 (20%)

[a] Referral diagnosis missing in 5/1420 who did not undergo PS and in 12/5383 who underwent PS.

Ethical approval is not a requirement for the service evaluation of routine clinical practice (UK NHS National Research Ethics Service guidelines), nevertheless the project was registered as a service evaluation with Sheffield Teaching Hospitals NHS Trust Clinical Effectiveness Unit.

3. Results

3.1. Demographics of those that did or did not undergo PS

PS was included in the EEG examination of 5383 patients (79%) from a total of 6807 undergoing routine EEG. The 5383 patients that underwent PS included 2061 children (≤17 years of age). In the 1277 patients for whom a reason for excluding PS was provided, the most commonly given reasons were: the patient was "too old" in 290 (23%), showed "insufficient cooperation" in 235 (18%), was "too young" in 120 (9%) and "patient refused" in 84 (7%). Those who did not undergo PS were older than those who did and PS was performed more frequently in patients referred with epilepsy and/or NEAD than for other diagnoses (Figs. 1 and 2; Table 1).

3.2. Efficacy: Evoking PPRs

A PPR occurred in the EEGs of 79 of 5383 cases that underwent PS (1.5%), being the first instance of an interictal epileptiform EEG feature in the terms defined by the project protocol. The referral diagnosis in cases whose EEGs contained PPRs was epilepsy in 75 cases, NEAD in 2 cases, epilepsy plus NEAD in 1 case and 'other' in 1 case.

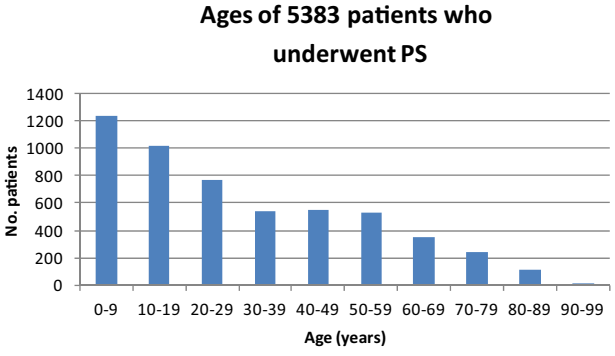

Fig. 1. Ages of 5383 patients who underwent PS.