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Which Electroencephalography for Seizure?: Survey Perfomed in Electro-medical Diagnostic Unit

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Abstract Electroencephalogram (EEG) aids the management of epilepsy. Sleep deprivation (SD) is useful to increase the diagnostic yields. However, there is concern about the burden imposed on family by depriving a child's sleep. The present study aims to evaluate the acceptability of SD-EEG. A two-year questionnaires survey was conducted in parents and children attending SD-EEG in the Electro-medical Diagnostic Unit, Tuen Mun Hospital. Preparation for the procedure was well accepted in 95%. Only 2.5% expressed very inconvenient to keep child awake. One-fifth of parents expressed inconvenience related to school non-attendance, 10% were anxious about seizure being triggered. No patient developed seizure related to the procedure. This survey indicates that SD is well tolerated and does not impose major burden. Resource implications of sleep deprivation in EEG may be considerable. Using SD-EEG as the preferred protocol may help to reduce the number of EEG carried out in children with seizures.

Key words Children; Electroencephalogram; Sleep deprivation

Introduction

Epilepsy is a heterogeneous group of chronic disorders characterised by recurrent, unprovoked seizures resulted from abnormal and excessive discharges of neurons in the brain.[1] Although the diagnosis of epilepsy is clinical, electroencephalograms (EEGs) have been recommended as a standard of care in the management of childhood epilepsies.[2] Demonstration of epileptic abnormalities in seizure disorders supports the diagnosis and plays a major role in classification of epilepsy into types and syndromes.[3,4] It carries an important implication on treatment choice, planned treatment duration and prognosis.[2]

Routine EEGs are normal in over half of the patients with epilepsy despite standard activation procedures such as hyperventilation, and photic stimulation.[5,6] If routine EEG reveals no epileptiform activity, long term EEG monitoring (video or ambulatory EEG) very often has to be performed in order to increase the detection rate of interictal and/or ictal events.[7]

The effects of sleep deprivation on EEG had been recognised for more than 50 years.[8] Sleep-deprivation EEG (SD-EEG) is an easy, effective and inexpensive way to increase yields of EEG abnormalities.[8,9] SD-EEGs have been reported to decrease the total number of routine EEG by 45% and probably can reduce the more expensive long-term EEG monitoring.[10] However, there is lack of common consensus of routine use of SD-EEG. Many units either do not use it routinely or reserve it if equivocal or negative results are present in the first EEG. One of the concerns is the assumed burden imposed on the family by depriving a

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child of sleep. Literature supporting the above assumption is scarce and there has been no report of perception of SD-EEGs in Chinese.[11] The present study aims to analyze the perception of SD-EEG.

Methods

A two-year questionnaires survey was conducted between December 2005 and January 2007 in the Electromedical diagnostic Unit, Tuen Mun Hospital. Only patients aged <18 years were recruited. Questionnaires were developed and distributed to parents and children older than 10 years attending SD-EEGs. Indications for SD-EEGs were epilepsy, unprovoked seizures, spells suspicious of seizure disorders. Obvious non-seizure diagnoses such as tics, headaches, syncope were not indications for EEG or SD-EEGs.[7]

All of the EEGs were performed by using a 21-channel digital recording with electrodes placed according to the international 10-20 systems. Routine EEG consisted of a normal recording of 20-30 minutes, including three minutes hyperventilation and intermittent photic stimulation at various frequencies.[7] Protocol for SD-EEG is age-dependent partial sleep deprivation.[12] Instructions were given to parents at time of appointment. Most SD-EEGs were performed in the afternoon, often after feeding, in a quiet and darkened room. Duration of recording was 30-40 minutes. SD-EEG instructions were as follows:

0-2 years of age: the child awake prior to the test for at least 1 hour

3-10 years of age: the child was allowed to sleep for a maximum of 7 hours the night before the test

11-15 years of age: the child was allowed to sleep for a maximum of 5 hours the night before the test

>15 years of age: the child had to stay awake after 12:00 am

The extent to which SD-EEG turned out to be inconvenient was assessed by questionnaires with regard to the following issues (Appendix): preparation for the investigation, keeping the child awake, parents themselves having to stay awake, waiting for the EEG in the morning, travelling home, settling nonattendance at work or household, nonattendance at school and whether they experienced the whole procedure as burdensome. For each topic, the respondents could choose one of the four options: "very inconvenient", "mildly inconvenient", "no problem" or "not applicable". Development of questionnaires was based on published literature. [11]

Results

Forty-two questionnaires were sent and response rate was 95% (Tables 1 and 2). Preparation for the procedure was well accepted in 95%. Only 2.5% expressed "very inconvenient" to keep child awake. One-fifth of patients expressed inconvenience relating to school nonattendance. Ten percent of the respondents were anxious about seizure being triggered during the transport. Tiredness and temper outburst due to sleep deprivation were indicated in 7.5% of respondents. 97.5% of patients thought they were well informed about the procedure. 92.5% felt SD-EEG not burdensome. No patient developed seizure during the procedure.

Discussion

EEG is not only valuable in the diagnosis of epilepsy, it helps to differentiate a seizure from other paroxysmal events such as breath-holding spells, syncope, gastro-esophageal reflux and pseudoseizures. EEG is also useful in the decision to perform further neuroimaging studies, it provides information on long term prognosis, and affects counseling about management of the child. Gibbs and Gibbs studied 500 patients with epilepsy, 36% showed epileptiform activity in the awake EEG.[13] Many EEGs have to be repeated. The detection of new information from the repeated EEG, however, is relatively low. This is well demonstrated in a study by Salinsky et al, which showed only 17% had new interictal epileptiform activity on second EEG, 13% on the third EEG, 10% on the fourth EEG, and 4% on the fifth one.[14]

An increased amount of epileptiform discharges were observed in sleep. Gibbs stressed the value of sleep: "every minute of sleep is more informative than an hour of waking record".[13] Subsequent studies have confirmed these findings.[15] The American Electroencepahlography Society's Guideline and Technical Standards states that "sleep recordings should be obtained whenever possible".[7]

Sleep deprivation is commonly used to induce sleep. Ellingson et al reviewed the literature and concluded that

Table 1 Extent of inconvenience when preparing for SD-EEG

	Very inconvenient	Slightly inconvenient	No problem	Not applicable
Preparation for investigation (%)	0	5	95	0
Keeping the child awake (%)	2.5	7.5	90	0
Helping the child to sleep before EEG (%)	2.5	12.5	70	15
Waiting for investigation (%)	0	2.5	95	2.5
Settling non-attendance at work or household (%)	0	12.5	67.5	20
Non-attendance at school (%)	0	20	65	15

Table 2 Tolerance of SD-EEG

	Yes (%)	No (%)
Is SD-EEG well-informed	97.5%	2.5%
Children felt unwell after sleep deprivation	7.5%	92.5%
Parents unwell after sleep deprivation	5%	95%
Whole procedure as burdensome	7.5%	92.5%
Seizure induced on the way to hospital	10%	90%
Seizure induced at home	12.5%	87.5%

SD seems to have activating effect on EEG beyond the production of sleep alone.[16] Tartara et al studied 87 children, 14% had epileptiform activity in their awake EEG and this increased to 54% after sleep deprivation.[17] Capray et al repeated SD-EEG in a cohort of children with normal routine-EEG and found that 34% of them showed various epileptiform abnormalities.[12] DeRoos et al also reported a modest increase in diagnostic yields of SD-EEG in children.[18] Despite the long-recognised effect of sleep deprivation on EEG, a recent review concluded that "little evidence, informed opinion, or guidance on sleep-deprived EEGs has penetrated to practitioners".[19] One of the concerns of routine use of SD-EEGs is the acceptability of sleep deprivation to the child and parent. The diagnostic gains may not offset the burden of SD. Assumption that SD-EEG is burdensome has not been well evaluated. So far, there is only one study by Nijhof et al[11] and the present study provides unique information of perception of SD-EEG in Chinese.

Our survey indicates that sleep deprivation EEG procedure is generally well accepted and does not impose major burden, even though it has created certain inconvenience to both parents and their children on leave arrangement. Parents were concerned about the potential risk of seizure being provoked because of sleep disturbance. However, none of our patients developed seizure related to sleep deprivation. Few patients indicated minor complaints such as tiredness and bad temper. The risk of using age-dependent partial sleep deprivation in children as illustrated by present study is acceptable. Our findings contrast with that reported by Nijhof et al, they observed 20% of the families consider SD-EEGs burdensome. Half of the parents reported complaints including fatigue and in two cases even an increase in seizure frequency. 47.1% of children described having symptoms the next day.[11] The difference in observation can be partly accounted by ethnic factors in these two studies.

Leach et al assessed the effects of different EEG protocols on the yield of EEG abnormalities in patient with new epilepsy. Sleep-deprivation EEG had a sensitivity of 92%, whereas the sensitivity of routine EEG and drug induced EEG was 44% and 58% respectively.[10] Of 100 young patients with possible new epilepsy, use of initial routine EEG (as is the standard in most units) may be expected to yield 19 patients with generalised epileptic abnormalities. If search of abnormal discharges is to be carried out, and if SD-EEG is to be performed instead of

repeated routine EEG, the remaining 81 would undergo SD-EEG, giving a total of 181 EEGs performed to fully screen 100 patients with possible idiopathic generalised epilepsy. In contrast, using SD-EEG as the preferred protocol would lead to 100 SD-EEGs being carried out. With a marginal longer examination time, this would result in 45% reduction of EEG requests.[10] Not to mention the potential reduction of long-term, more expensive EEG monitoring (video or ambulatory EEG) if routine EEG repeatedly reviewed no abnormalities.

To conclude, the role of EEG in the management of seizure disorders is important by directing resources, treatment and prognostication. The diagnostic yield and the confidence in a "negative" result need to be enhanced. SD-EEG had been reported to be superior in activating abnormalities. There may be some negative aspects of carrying out SD-EEG; recording times may be slightly longer and there may be a slightly increased risk of seizure provocation related to sleep deprivation. However, as observed in the present survey, the procedure is well tolerated in patients. We believe SD-EEG after partial, age-dependent sleep deprivation is a safe and cost-effective diagnostic procedure. Resource implication of the initial use of sleep deprivation may be considerable. Using SD-EEG as the preferred protocol may help to reduce the number of EEG including long-term EEG monitoring being carried out in children with seizures. However, to achieve effective service outcome, the patients should be well informed of the procedure and anyone with a history of sleep-deprived seizures should be offered routine EEG as the first option.

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Appendix

Questionnaires

	Very inconvenient	Slightly inconvenient	No problem	Not applicable
1. Preparation for investigation				
2. Keeping the child awake				
3. Helping the child to sleep before EEG				
4. Waiting for investigation				
5. Settling non-attendance at work or household				
6. Non-attendance at school				

	Yes	No
7. Is SD-EEG well-informed		
8. Children felt unwell after sleep deprivation		
If yes, please state symptoms: ( )		
9. Parents unwell after sleep deprivation		
If yes, please state symptoms: ( )		
10. Whole procedure as burdensome		
11. Seizure induced on the way to hospital		
12. Seizure induced at home		