ORIGINAL ARTICLE

Factors affecting the occurrence of high-frequency positive occipital sharp transients of sleep

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Abstract. To elucidate possible factors affecting the incidence of high-frequency positive occipital sharp transients of sleep (H-POSTS) and to investigate whether H-POSTS are associated with any specific pathophysiological conditions, we visually inspected on consecutive routine diurnal EEGs (2705 records) using our criteria for identification of H-POSTS. H-POSTS were observed in 164 records (subject age: 7.9 to 83.2 years). The incidence of H-POSTS was lower in subjects with highly abnormal EEG findings. Female subjects had a significantly higher incidence of H-POSTS than males that could not be explained by other factors. Patients with either fainting or headache had a significantly higher incidence of H-POSTS and lower grade of EEG abnormality. The precise mechanism of the gender difference in the incidence of H-POSTS could not be determined. The occurrence of H-POSTS seemed to be associated with healthy sleep macrostructure, rather than with any specific pathophysiological phenomena. (Keio J Med 52 (1): 25–29, March 2003)

Key words: electroencephalography (EEG), sleep, high-frequency POSTS (H-POSTS), gender

Introduction

Positive transient EEG deflections have been noted during sleep, and Gibbs *et al.* referred to the waveforms as 'positive spike-like waves in the occipital areas'.¹ Vignaendra *et al.* called them 'positive occipital sharp transients of sleep (POSTS)' and described similarities in shape and topography to lambda waves during awake records, suggesting that POSTS are related to the fixation of visual informations.²

POSTS occur singly or repetitively. To our knowledge, Blume and Kaibara³ were the first to use the term 'high-frequency POSTS' (H-POSTS) for frequently repeating POSTS and to describe them in detail. Although little is known about repetitive POSTS or H-POSTS, some have proposed that they are related to certain pathophysiological conditions. First, Vignaendra *et al.* presented an example of repetitive POSTS recorded in a patient with fainting spells,² not a healthy subject. Second, dysthymic patients have been reported to have a significantly higher incidence of POSTS than normal controls.⁴ Third, the frequency (around 6 Hz) and the distribution (often posteriorly-distributed) of H-POSTS resemble those of 6 Hz positive spikes, which heve been reported to be associated with behavior disorders.⁵ However, because these data were collected from groups containing small number of subjects, the pathophysiological significance of H-POSTS has not yet been determined.

Since EEG recordings from a large population are needed, to strictly determine whether H-POSTS are associated with any disorders or symptoms, we investigated a large EEG cohort of Keio University Hospital patiens to search for factors that might affect the occurrence of H-POSTS.

Methods

Consecutive routine diurnal EEGs recorded at Keio University Hospital during October 1999 and June 2000 were visually inspected by one of the authors (M.S.). Only the first record during the study period of each

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Fig. 1 An example of high-frequency POSTS (H-POSTS) in a sleep record of a 51-year old male who complained of fainting spells. Simultaneous recordings with different time constants (0.3 sec and 0.1 sec) are shown in P3, P4, O1, O2, T5, and T6. Arrowheads: H-POSTS. Scale: 50 microvolts, 1 sec. Note that there are no obvious differences in the shape, duration, or amplitude of H-POSTS under different time constant conditions.

subject was investigated. The time constant of the amplifier was set at either 0.1 sec or 0.3 sec according to the situation.

The criteria for identification of H-POSTS were:

(1) occurs in sleep-pattern EEG, (2) consists of three or more consecutive positively-peaking deflections with five to seven waveforms/sec, (3) amplitude of each waveform is 30 μ V or more, (4) duration of each waveform is 80 msec to 200 msec, (5) distribution is limited to the occipital area, and to any one of the neighboring electrode sites, if extended.

The clinical data and EEG findings were stored in a Lotus 1-2-3 file. The EEG abnormality was graded according to the descriptions of Ichijo and Saunders.⁶

Statistical analyses were performed on 'Dr. SPSS for Windows' (SPSS Japan Co.).

All data management was carefully conducted exclusively by the authors to protect the subjects' privacy. No clinical data was registered, if a candidate refused any EEG recordings.

Results

An example of H-POSTS in the occipital area recorded simultaneously with two different time constants is shown in Figure 1. No obvious differences in the shape, duration, or amplitude of the H-POSTS were observed out between the two time-constant conditions.

During the investigation period, the 1627 sleep EEG records among the 2705 total contained 164 records with H-POSTS (subject age: 7.9 to 83.2 years).

Two subjects (1 male with retinitis pigmentosa who was legally blind with light perception and 1 male lacking the right eyeball) had disturbances of the retina, which have been reported to reduce the occurrence rate of POSTS.⁷ Neither subject slept during the EEG session.

Table 1 shows the age-distribution of the records containing H-POSTS. The incidence of H-POSTS in 1000 sleep records (age-stratified and adjusted to the Japanese population of the year 2000^8) was 96.19.

Table 1 Number of Routine EEG Records with Sleep Pattern andthe Incidence of H-POSTS. Diurnal Sleep was Recorded in 1627 of the2705 EEG Records. Note That Children (Under 7.9 Years Old) andElderly Subjects (Above 83.2 Years Old) did not Exhibit H-POSTS

Age	Number of sleep records	Number of records with H-POSTS
0-4	109	0
5–9	54	1
10-14	71	5
15-19	116	21
20-24	188	25
25-29	143	19
30-34	142	19
35-39	95	11
40-44	74	4
45-49	78	10
50-54	137	12
55-59	102	11
60-64	71	8
65-69	93	9
70–74	69	3
75–79	50	5
80-84	25	1
85-89	9	0
90-94	0	0
95–99	1	0
100 =<	0	0
	1627	164

 Table 2
 Number of Sleep Records and Records with H-POSTS

 According to the Purpose of the EEG Recording

	Number of sleep records	Number of records with H-POSTS
Epilepsy	638	62
Headache	166	25
Fainting	149	25
Convulsion NOS	75	7
Dizziness/Vertigo	60	5
Depression	35	4
Brain infarction	33	0
Febrile convulsion	23	0
Others	448	36
	1627	164

NOS: not otherwisely specified.

The number of sleep records with H-POSTS according to the purpose of the EEG recording (classification of diagnoses or chief complaints) is shown in table 2. None of the values in the Table was independent of the others (df = 8, $\chi^2 = 20.673$, p < 0.01). The incidence of H-POSTS in 'fainting' (df = 1, $\chi^2 = 8.12$, p < 0.005) and 'headache' (df = 1, $\chi^2 = 5.06$, p < 0.05) was significantly higher.

Table 3 Relationship Between Incidence Rate of H-POSTS andDeepest Sleep Stage in 1506 Sleep Records (Subject Age: 5 to 84Years)

Deepest sleep stage	Number of sleep records	Incidence rate of H-POSTS
Stage 1	480	0.025
Stage 2	997	0.150
Stage 3/4	29	0.100

Table 4EEG Abnormality and Incidence Rate of H-POSTS. Fiveof the Records Showed a Grade 5 EEG Abnormality during theRegistration Period (2 Isoelectric, 3 Hypsarrhythmia), and 25 Records(Including 8 Records with Sleep Patterns) Showed a Grade 4 Abnormality

Grade of EEG abnormality	Number of sleep records	Incidence rate of H-POSTS
0	824	0.110
1	88	0.140
2	336	0.140
3	250	0.060
4	8	0.000
5	0	-

Because H-POSTS were observed among records from small age-stratified groups (5 to 84 years old, 1506 sleep records), the following analysis were performed on the 1506 records.

Logistic regression analysis of the occurrence of H-POSTS extracted deepest sleep stage (p < 0.001), degree of EEG abnormality (P = 0.0158), and gender (p < 0.001) as significant factors.

Table 3 shows the incidence of H-POSTS according to deepest sleep stages. The Stage 1 group had a significantly lower rate than the other groups (Kruskal-Wallis test, p < 0.001).

Table 4 shows the relationship between the incidence of H-POSTS and grade of EEG abnormality. Records with grade 3 or 4 abnormality contained significantly fewer H-POSTS (Kruskal-Wallis test, p = 0.032).

The incidence of H-POSTS in male subjects (54 of 785 sleep records) was significantly lower than that in female subjects (110 of 721; df = 1, $\chi^2 = 27.496$, p < 0.001). No gender difference was observed in deepest sleep stage or EEG abnormality. Records from subjects with fainting (df = 2, $\chi^2 = 13.145$, p < 0.002) and headache (df = 2, $\chi^2 = 31.262$, p < 0.001) showed significantly less EEG abnormality.

Six-Hz positive spikes were observed in 24 cases (15 of epilepsy, 3 of headache, 2 of dizziness, 1 of convulsion of unknown etiology, 1 of anorexia nervosa, 1 of disorientation, 1 of amnesia of unknown etiology). No significant differences in age, gender, or diagnosis, were detected among patients with 6 Hz positive spikes. One subject exhibited H-POSTS and 6 Hz positive spikes within the same record.

Discussion

Diurnal EEG and POSTS

Ideally sleep microstructures, such as POSTS, should be investigated by recording whole-night EEGs or polysomnograms. However, it is impossible to perform whole-night studies on hundreds of consecutive subjects in an EEG laboratory. Diurnal EEG has the advantage of allowing large numbers of records to be obtained.

Since the incidence of POSTS has been reported to be highest during the initial 30-minute period of NREM sleep after sleep onset in both nocturnal and diurnal sleep,⁹ the incidence rate of POSTS in routine diurnal sleep EEGs was expected to be nearly as high as in whole-night records.

For this reason diurnal routine EEGs are the best choice for studying POSTS in a large population.

Definition and detection of H-POSTS

The definition of H-POSTS must be based on the definition of POSTS.²

Repetition can be defined as the presence of two or more waveforms, however, it is sometimes difficult to distinguish two consecutive POSTS from POSTS and a non-specific waveform. Since identification of three or more POSTS is definitely easier and more reliable, investigations of 'three or more' consecutive POSTS may provide higher quality data than 'two or more' consecutive POSTS.

Repetitive POSTS has been of interest because it resembles 6 Hz positive spikes. Thus, the definition of the frequency of H-POSTS must be around 6 Hz. Positive repetitive waveforms occurring at around 8 Hz, which resemble not only POSTS but traces of alpha activity, rarely occur present during stage 1 NREM sleep. The frequency restriction of H-POSTS must be under 7 Hz to exclude this unidentified waveform.

The incidence of Japanese subjects showing POSTS has been reported to be 64% (35 of 55 normal volunteers) and 53% (71 of 134 patients with tension headache, migraine, or neurosis).⁹ The incidence of H-POSTS in our study (164 of 1627 records, 96.19 of 1000 age-adjusted Japanese population) was lower, possibly because of the strict criteria we used to identify H-POSTS.

Since inter-inspector reliability for detecting H-POSTS has never been investigated, all EEGs should be inspected by the same clinical neurophysiologist, even when the number of EEGs is large. Each EEG in our study was recorded with a time constant of 0.1 sec or 0.3 sec. It is generally known that identical electrical activity may be represented by different waveforms when different time constant settings are used, thereby possibly influencing the detection of H-POSTS. However, as shown in Figure 1, since waveforms with the duration of 200 ms or less (such as POSTS) were hardly affected at all by the difference between time constant of 0.1 sec and 0.3 sec, it was possible to use records with either time constant setting in the study.

Classification of the purpose of EEG recording

As shown in Table 2, the purposes of the EEG recordings could be categorized into according to clinical diagnoses and symptoms. Determining the incidence of H-POSTS in patients with a certain established diagnosis was one of the purposes of this study. The incidence of H-POSTS in subjects without an established diagnosis was also of interest, because H-POSTS may be related to phenomena other than clinical entities. In order search for possible factors (diagnoses, symptoms, or complaints that) affecting the incidence of H-POSTS, we did not eliminate the data of subjects in whom a diagnosis had not yet been made.

Sleep macrostructure, EEG abnormality, and H-POSTS

The incidence of POSTS has been reported to be higher in healthy subjects in their 20's to 40's who exhibit well-organized sleep macrostructure, especially stage 2 or 3 NREM sleep. Conversely, children (in whom sleep structure is immature¹⁰), elderly (in whom sleep structure changes with age), and patients with brain disorders that affect sleep structures have been reported to exhibit fewer POSTS.¹¹ Thus, age and grade of EEG abnormality are known to be factors affecting the stability of sleep macrostructure.

The characteristics of POSTS described above were also exhibited by H-POSTS. The occurrence of H-POSTS clearly depended on sleep macrostructure in which stage 2 or deeper NREM sleep lasted for tens of minutes (Table 3).

Theoretically, the occurrence of H-POSTS might be related to pathophysiological phenomena in three possible ways. (1) The incidence of H-POSTS might increase as brain damage becomes severer. (2) H-POSTS might represent certain brain reactions to disease, and thus the incidence of H-POSTS might be higher when brain damage is mild and lower when brain damage is severer (because the brain reaction may be weak or absent) or absent (because there is no need to react). (3) The incidence of H-POSTS might decrease as brain damage becomes severer. The first (1) or the second (2) models would be the basis of the view that repetitive POSTS are a marker of certain pathophysiological phenomena, however, no evidence of (1) or (2) was obtained in this study. Our data in Table 4 seem to support the third (3) model, in which H-POSTS are thought to be of no pathophysiological significance.

We previously reported that fainting patients tend to show more H-POSTS than other patients,¹² and the present study for the first time showed a significantly higher incidence rate of H-POSTS in patients with headache. Nevertheless, at present there is no direct evidence that either fainting or headache is the cause of the increased incidence of H-POSTS. One possible explanation is that the incidence of H-POSTS is higher in patients with fainting or headache because such patients have significantly lower grade of EEG abnormalities.

Taken together, the above findings suggest that the occurrence of H-POSTS might not provide any evidence of a specific pathophysiological condition, but instead reflect the stability of sleep structure with lesser grades or no EEG abnormalities.

Gender and H-POSTS

The gender difference in the incidence of H-POSTS was the most unexpected finding in this study and could not be explained by the difference in age or EEG abnormality in each gender population. Only a small part of the difference could possibly be explained by the gender difference in several diseases (e.g., eating disorder, no males and 13 females, 3 H-POSTS; brain tumor, 13 males and 6 females, no H-POSTS, etc.). In other smaller consecutive EEG cohorts (Saiseikai Utsunomiya Hospital with 281 sleep records and Akebono Clinic with 117 sleep records, Oct. 1999-Jun. 2000), no gender difference in the incidence of H-POSTS was observed (data not shown), suggesting that the gender difference of H-POSTS might have arisen from possible selection bias. To determine whether male subjects tend to exhibit fewer H-POSTS than females, the incidence of H-POSTS should be tested in other large populations.

Conclusions

The incidence of H-POSTS was affected by age, degree of EEG abnormality, deepest sleep stage, and gender. The incidence of H-POSTS was significantly higher in female patients, but the precise mechanism of this gender difference has yet to be determined.

The incidence of H-POSTS was significantly higher in patients with fainting or headache. This could possibly be explained by significantly lower degree of EEG abnormality in these subjects.

The occurrence of H-POSTS appears to be associated with a lesser degree of EEG abnormality, rather than to represent any specific pathophysiological phenomena.

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