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Detection Rates of Interictal Epileptiform Discharges in Epilepsy Patients: A Comparison of Routine, 1-3 Hours Daytime, and Whole-night EEG Recordings

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Abstract

Objective: The detection rate of interictal epileptiform discharges (IEDs) varies among electroencephalography (EEG) recordings in patients with epilepsy. This study aimed to compare the yield of IED detection across three recording protocols of varying durations routinely used at our center: routine 20-30 minutes EEG, 1-3 hours daytime video-EEG (vEEG), and whole-night (8-12 hours) vEEG.

Methods: The EEG reports of adult patients treated at the Dokuz Eylül University Hospital epilepsy outpatient clinic between 2006 and 2024 were retrospectively reviewed. Patients older than 18 years who had undergone at least one routine EEG, one 1-3 hours daytime vEEG, and one whole-night vEEG on separate occasions were included. The detection rates of IEDs across the three modalities, along with patients' clinical characteristics, were analyzed.

Results: Seventy-three patients (43 women and 30 men) were included in the study. For the initial EEG, the IED detection rate was 17.8% for routine EEG, 45.2% for 1-3 hours daytime vEEG, and 46.6% for whole-night vEEG. The routine EEG detection rate was significantly lower (p=0.001). With repeated examinations, the yield of routine EEG increased to 41.1%, daytime vEEG to 52.1%, and whole night vEEG to 56.2%; with no significant difference between the modalities (p=0.099).

Conclusion: Although IED detection was highest with whole-night vEEG, daytime 1-3 hours vEEG recordings that included sleep achieved a comparable yield and may be preferred to reduce laboratory workload. The recording duration can be individualized according to the laboratory resources and patient preferences.

Keywords: Electroencephalography, interictal epileptiform discharges, recording duration

INTRODUCTION

Electroencephalography (EEG) is extensively used for the diagnosis and monitoring of epilepsy, with the primary objective of capturing interictal epileptiform discharges (IEDs). However, IEDs are not consistently detectable in every EEG recording.

The reported detection rate of IEDs in the initial routine 20-30 minutes EEG ranges from 28% to 53% in patients with epilepsy.[1-3] In instances where IEDs are not identified, routine EEG may be repeated. Conducting routine EEG three times can increase the detection rate to 77%.[2] Alternatively, longer recording durations may have been required. Extending the routine EEG to 45 min has been demonstrated to enhance the yield of IEDs.[4] Ambulatory EEG or whole-night video-EEG (vEEG) can also be used. In patients experiencing a single unprovoked seizure, 24-hour vEEG detects IEDs in 44-57% of cases.[5,6] Comparative studies between ambulatory 24-h EEG and the first two routine EEGs have indicated a higher sensitivity for ambulatory 24-h EEG.[7,8]

In our center, in addition to routine EEG, we used daytime 1-3 hours vEEG and 8- to 12-hour whole-night vEEG to detect IEDs. In this study, we analyzed the IED detection rates in recordings conducted at various times and durations in patients with epilepsy. We also compared the relative performance of repeated routine EEG, daytime 1-3 hours vEEG, and whole-night vEEG.

METHODS

EEG recordings of patients who were followed up in the epilepsy outpatient clinic of Dokuz Eylül University Hospital between 2006 and 2024 were reviewed retrospectively. Adult patients (≥18 years) who underwent at least one routine EEG, one 1-3 hours daytime vEEG, and one whole-night vEEG on separate occasions were included in the study. Patients who did not have results from any of these three modalities were excluded. Additionally, repeated EEGs of patients in these three modalities were examined. A comparison was made between the initial and cumulative EEG IED detection rates. The purposes of the EEG recordings were classified as follows: diagnosis and follow-up. The diagnostic EEG included the diagnosis of epilepsy and classification of epilepsy syndromes. Follow-up EEG was conducted for various reasons, including changes in seizure frequency and assessment prior to withdrawal of anti-seizure medication (ASM).

Routine EEGs were obtained in the outpatient setting with the patient seated comfortably for 20-30 min. Daytime 1-3 hours and whole-night vEEG recordings were performed with the patient lying on a bed in a quiet, dark room. Whole-night vEEG lasted 8-12 hours. All the EEGs used the international 10-20 electrode system. The recordings were evaluated by a clinical neurophysiologist or a clinical neurophysiology resident.

Demographic data, ASMs at the time of the last visits, brain magnetic resonance imaging (MRI), and seizure frequencies for the last year were recorded. If the brain MRI could not be accessed from the records, it was classified as unknown; if available, it was classified as normal or abnormal.

Recordings were examined for the presence of IEDs, defined as spikes, spike-and-wave discharges, sharp waves, temporal intermittent rhythmic delta activity, and generalized spike-and-wave discharges. The IEDs were classified as generalized, focal, or multifocal. The localization of focal IEDs was recorded.

This study was approved by the Dokuz Eylül University Non-Interventional Research Ethics Committee (approval no: 2025/02-05, date: 15.01.2025).

Statistical Analysis

Statistical analyses were performed using IBM SPSS version 23 (Inc., Armonk, NY, USA). Normality was assessed using the Shapiro-Wilk test. Associations between independent categorical variables were analyzed using the Yates corrected χ^2 test, Fisher's exact test with Monte Carlo correction, or Pearson's χ^2 test with pairwise comparisons using the Bonferroni corrected Z test. Cochran's Q test was used for dependent categorical variables. The Mann-Whitney U test was used to compare non-normally distributed continuous variables between the two groups. The results for categorical variables are presented as frequency (percentage); continuous variables are presented as mean ± standard deviation and median (minimum-maximum). Statistical significance was set at $p<0.05$.

MAIN POINTS

- This study evaluated the interictal epileptiform discharge (IED) detection rates across routine electroencephalography (EEG), 1-3 hours daytime video-electroencephalography (vEEG), and whole-night vEEG in adult patients with epilepsy.
- Seventy-three patients who underwent all three EEG modalities on separate occasions were retrospectively included.
- Routine EEG had a significantly lower initial IED detection rate (17.8%) compared to daytime vEEG (45.2%) and whole-night vEEG (46.6%).
- Repeated recordings increased detection rates across all modalities, eliminating statistically significant differences.
- Daytime vEEG with sleep achieved a detection yield comparable to whole-night vEEG and may offer a practical alternative to reduce laboratory burden.

RESULTS

In total, 73 patients (43 women, 30 men) were analysed. Their clinical and EEG characteristics are summarised in Table 1. The ASMs used are shown in Figure 1. In this study, a total of 195 EEGs were analyzed. Of these, 36 EEGs were conducted for diagnostic purposes and 159 were performed for follow-up assessments. Nineteen routine EEGs, 8 daytime vEEGs lasting 1-3 hours, and 9 whole-night vEEGs were performed for diagnostic purposes. With repeated EEG recordings, the average number of routine EEGs was 2.8; the number of 1-3 hours daytime vEEGs was 1.6; and the number of whole-night vEEGs was 1.5.

In the initial recording, the detection rates of IEDs were 17.8% for routine EEG, 45.2% for daytime 1-3-h vEEG, and 46.6% for whole-night vEEG. Notably, routine EEG was significantly less effective than the other two vEEG modalities (p=0.001).

With repeated recordings, the IED yield of routine EEG increased to 30.2% on the second, 36.9% on the third, and 41.1% on the fourth study. For daytime 1-3 hours vEEG the yield increased to 50.6% on the second and 52.1% on the fourth recording. For whole-night vEEG, the second recording yielded 56.2%, with no further increase thereafter (Figure 2). Across repeated examinations, there was no significant difference in IED detection among the three modalities (p=0.099).

Table 1. Demographic and clinical characteristics of the patients

Age (years)	37.27±12.6 (20-69)
Epilepsy duration (years)	16.4±6.3 (6-31)
Number of routine EEGs	2.8±1.7 (1-7)
Number of 1-3 hours daytime EEGs	1.56±0.7 (1-4)
Number of whole-night EEGs	1.45±0.9 (1-6)
Cranial MRI, n (%)	
Normal	16 (21)
Abnormal	25 (34.2)
Unknown	32 (44.8)
Seizure frequency per year, n (%)	
≤1	44 (60.3)
2-6	8 (11)
7-12	5 (6.8)
≥13	16 (21.9)
ASM use, n (%)	
Yes	65 (89)
No	8 (11)
Number of ASMs, n (%)	
1	29 (39.7)
2	25 (34.2)
>2	11 (26.1)

ASM: Anti-seizure medication, MRI: Magnetic resonance imaging, EEG: Electroencephalography

IEDs were detected by at least one of the three modalities in 78.1% of the patients, whereas 21.9% showed no IEDs on any study. The proportions of generalised and focal IEDs detected by the three modalities were similar (p=0.49, p=0.38, p=0.73) (Figure 3).

IED detection on any routine EEG, daytime 1-3 hours or whole-night vEEG was not significantly related to ASM use, last year seizure frequency, or MRI abnormalities (Table 2).

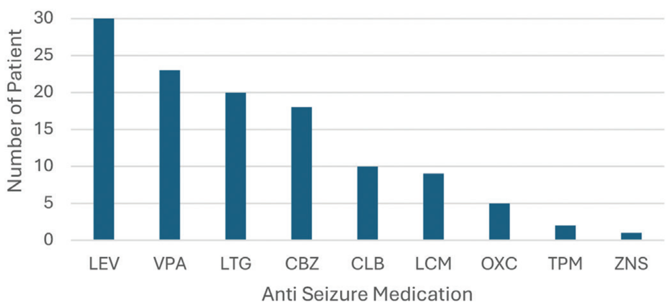

Figure 1. Antiseizure medications used by the patients
CBZ: Carbamazepine, CLB: Clobazam, LCM: Lacosamide, LEV: Levetiracetam, LTG: Lamotrigine, OXC: Oxcarbazepine, TPM: Topiramate, VPA: Valproic acid, ZNS: Zonisamide

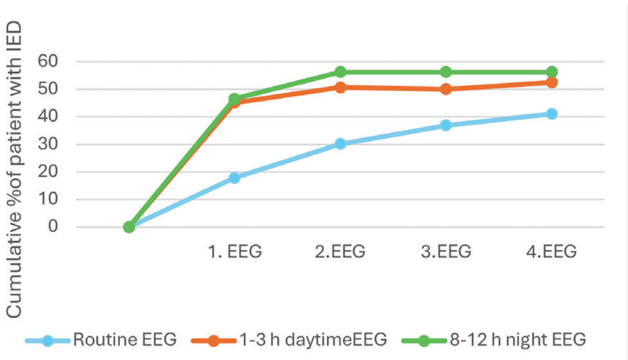

Figure 2. IED detection rates in repeated routine EEG, 1-3 hours daytime vEEG, and whole-night vEEG
IED: Interictal epileptiform discharge, EEG: Electroencephalography, vEEG: Video-electroencephalography

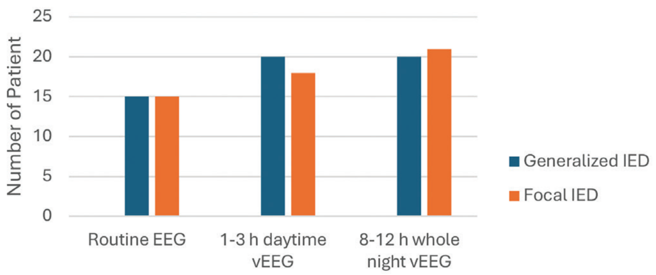

Figure 3. Detection rates of generalized and focal IEDs in routine, 1-3 hours daytime vEEG, and whole-night vEEG
IED: Interictal epileptiform discharge, EEG: Electroencephalography, vEEG: Video-electroencephalography

DISCUSSION

The detection of IEDs on EEG is crucial for effective management of epilepsy. This study demonstrates that both daytime 1-3 hours vEEG and whole-night vEEG recordings identify a greater number of IEDs than the first routine EEG. However, four or more routine EEGs achieved an IED yield comparable to that of longer recordings.

The probability of detecting IEDs increases with recording duration. Extending routine EEG to 45-60 min has been reported to provide an additional yield.[4,9] The benefit may relate not only to a longer duration but also to the inclusion of sleep, which facilitates IED generation.[10] A study investigating the frequency of IED detection by extending the duration of routine EEG to 60 minutes, found that IEDs occurring after 30 minutes were more prevalent in those who slept after the first 30 min.[4] As sleep state was not systematically documented for routine EEGs, we could not analyze its effect.

Although the whole-night vEEG group, with durations of 8-12 hours, had higher IED detection rates than the daytime vEEG group, the difference was not statistically significant. In our study, EEG recordings were conducted at the same location, which was slightly dark and quiet, for both 1-3 hours and a whole night. This environment facilitated the patients' capacity to fall asleep during the 1-3 hours daytime EEG sessions. As a result, the absence of a statistically significant difference between the 1-3 hours daytime and whole-night vEEG recordings may be attributed to the inclusion of sleep in the 1-3 hours vEEG. A study reported that the detection rate of IEDs in patients with epilepsy was similar in 30-60 minutes sleep deprivation EEGs compared to 24-hour ambulatory EEGs.[11] This study and our findings suggest that sleep is as crucial as the extension of EEG duration for the detection of IEDs. An EEG recording of at least one hour that includes sleep may be effective in detecting IEDs.

Conversely, prior research has indicated that extended recording durations improve the detection rate of IED. A study involving whole-night EEG on patients with epilepsy reported an IED detection rate of 57.4%.[12] Detection rates ranging from 74% to 89% within 24 hours[13,14] and from 88% to 95% within 48 hours[11,13] were observed. Therefore, recordings lasting 24 to 48 hours may be considered when it is necessary to enhance the likelihood of IED detection.

Previous studies have reported IED detection rates of 28-53% in a single routine EEG, increasing to 59-77% with repeated routine EEGs.[1-3] In our study, IED detection rates also increased with repeated routine EEGs. On initial examination, both 1-3 hours daytime vEEG, and whole-night vEEG were superior to routine EEG. However, performing video EEG on all patients instead of routine EEG is impractical. Therefore, the choice of EEG modality should be based on the clinical and laboratory conditions.

When the three methods were collectively evaluated, the overall detection rate of IEDs was superior to that of each method individually. Considering that sleep duration is longest in whole-night vEEG, this discrepancy may reflect the variable nature of IED occurrence.[15] Consequently, even in long-term EEG recordings in which no IED is detected, EEG repetition should not be avoided.

Table 2. Association between clinical features and IED detection (n, %)

	Routine EEG IED+	p	1-3 hours daytime vEEG IED+	p	8-12 hours whole night vEEG IED+	p
Sex						
Female	18 (60)	1.0	24 (63)	0.60	23 (56)	0.76
Male	12 (40)		14 (37)		18 (44)	
Epilepsy type						
Generalised	15 (30)	0.67	20 (53)	0.40	20 (49)	0.30
Focal	15 (30)		18 (47)		21 (51)	
ASM use (last visit)						
Yes	26 (87)	0.44	32 (84)	0.43	36 (88)	1
No	4 (13)		6 (16)		5 (12)	
Seizure frequency (/last year)						
<1	16 (53)	0.41	20 (52)	0.34	21 (51)	0.09
2-6	5 (17)		5 (13)		4(10)	
7-12	3 (10)		4 (11)		5 (12)	
>12	6 (20)		9 (24)		11 (27)	
Cranial MRI						
Normal	5 (17)	0.66	7 (18)	0.29	11 (27)	0.26
Abnormal	11 (37)		11 (29)		11 (27)	
Unknown	14 (46)		20 (53)		19 (46)	

ASM: Antiseizure medication, EEG: Electroencephalography, IED: Interictal epileptiform discharge, MRI: Magnetic resonance imaging, vEEG: Video electroencephalography

Study Limitations

The limitations of our study include the retrospective analysis of patients with varying clinical features in an epilepsy outpatient clinic. The indications for EEG varied; some patients underwent evaluation prior to the discontinuation of ASMs, while others experienced an increased frequency of seizures. Most patients used ASMs, which may have influenced the detection of IEDs. Some ASMs are known to affect the occurrence of IEDs;[16] possibly contributing to a lower IED detection rate in repeated routine EEGs as reported in the literature. However, our study did not find any relationship between ASM use and IED detection. The rate of IED detection increases in EEGs performed within the first 24-hour after a seizure.[12] Nevertheless, due to inadequate documentation, our study did not specify the duration between the last seizure and the performance of the EEG. Another limitation is the lack of documentation of sleep status in routine EEGs.

CONCLUSION

In conclusion, our findings suggest that with four or more repeated routine EEGs, the IED detection rate can approach that of 1-3 hours daytime vEEG and whole-night vEEG. Daytime vEEG of 1-3 hours, including sleep, and a whole-night vEEG, is similar for detecting IEDs. The duration of EEG recording should be determined based on patient and physician preferences as well as EEG laboratory conditions.

Ethics

Ethics Committee Approval: This study was approved by the Dokuz Eylül University Non-Interventional Research Ethics Committee (approval no: 2025/02-05, date: 15.01.2025).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Concept: İ.Ö., B.B., Design: İ.Ö., Data Collection or Processing: İ.Ş.Ö., L.Ç., Analysis or Interpretation: İ.Ş.Ö., A.Y.E., Literature Search: İ.Ş.Ö., L.Ç., Writing: İ.Ş.Ö., A.Y.E., B.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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