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The Application of Video Electroencephalogram in the Classification and Diagnosis of Post-Stroke Epilepsy

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Abstract: *Objective:* To explore the value of video electroencephalogram in the classification and diagnosis of post-stroke epilepsy. *Methods:* The medical records of patients diagnosed with suspected post-stroke epilepsy in our hospital from November 2020 to November 2023 were retrospectively analyzed, and a total of 116 research subjects were included based on several inclusion and exclusion criteria. All patients had undergone video and conventional electroencephalogram. The detection of epileptic discharges and clinical symptoms by the two methods were evaluated, their diagnostic efficacies were compared, and the effect of video electroencephalography on post-stroke patients was analyzed. Classification of epilepsy. *Results:* The comprehensive clinical diagnosis conclusion showed that among 116 patients with suspected post-stroke epilepsy, a total of 64 cases were diagnosed. The diagnostic accuracy, specificity, and sensitivity of video electroencephalogram were significantly higher than those of conventional electroencephalogram. Besides, among the patients diagnosed with post-stroke epilepsy, the detection rate of epileptiform discharges and clinical seizures by video electroencephalogram was significantly higher than that of conventional electroencephalogram ($P < 0.05$). Among the clinical seizure cases detected by video electroencephalogram, only 6 cases were inconsistent with the epilepsy classification based on a comprehensive clinical diagnosis. *Conclusion:* Video electroencephalogram has important value in diagnosing and classifying post-stroke epilepsy.

Keywords: Video electroencephalography; Conventional electroencephalography; Post-stroke epilepsy; Classification; Diagnosis

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1. Introduction

Epilepsy is a common neurological complication after a stroke, and it is reported that 5% to 20% of stroke cases are accompanied by epileptic seizures [1]. For stroke patients, epileptic seizures can cause persistent changes in the brain, aggravate neurological damage, and negatively affect clinical prognosis. Therefore, early and accurate diagnosis and classification of post-stroke epilepsy are of vital significance to controlling the patient's condition and ensuring clinical efficacy. Electroencephalography (EEG) is currently the primary method of diagnosing epilepsy. However, the recording time of conventional electroencephalography is short (generally 20–40 minutes). Because epileptiform discharges are highly random and it is difficult to capture epileptic waves, the detection rate of epilepsy is low [2]. Video EEG enables synchronized recording that allows continuous monitoring of brain wave changes over 24 hours. This method is complemented by video monitoring of various body activities, enhancing the diagnostic accuracy of epilepsy [3,4]. To further explore the value of video EEG in the classification and diagnosis of post-stroke epilepsy and to guide clinical diagnosis, treatment, and prognosis assessment, we retrospectively analyzed the EEG and routine evaluation results of 116 patients with post-stroke epilepsy who were previously admitted to our hospital.

2. Materials and methods

2.1. Information

Screening of research subjects: The hospitalization data of patients with suspected post-stroke epilepsy who were diagnosed in our hospital from November 2020 to November 2023 were collected and retrospectively analyzed. Finally, 116 research subjects were included based on several inclusion and exclusion criteria.

Inclusion criteria: (1) First epileptiform seizure and diagnosed as suspected epilepsy by a neurologist, (2) completed video EEG and conventional EEG in our hospital, (3) complete medical record, (4) gave consent to the study. Exclusion criteria: (1) Family history of epilepsy, (2) non-post-stroke epilepsy, (3) presence of major underlying diseases (malignant tumors, organ dysfunction, other neurological diseases, etc.) or mental illness.

The sample was composed of 77 males and 39 females, aged 48–73 years (mean age: 58.33 ± 7.49 years). Among them, there were 49 cases of cerebral infarction and 67 cases of cerebral hemorrhage.

2.2. Method

All cases underwent EEG and conventional EEG by the same group of senior EEG physicians, and a clear diagnosis of epilepsy was made. Detection operations:

(1) Conventional EEG

In conventional EEG, the patient was assisted into a sitting position and instructed to stay relaxed. The electrodes were placed on the scalp according to the international 10–20 system. The EEG monitoring parameters were set including a high-frequency filter set to 70 Hz and a time setting of 0.3 s. Recordings were conducted during both awake and sleeping states, incorporating relevant induction tests (such as opening and closing the eyes, flash stimulation, hyperventilation, etc.) during awake state recordings. The detection process was typically completed within 20 to 30 minutes, and the results were saved to the computer's hard disk for subsequent playback and analysis.

(2) Video EEG

The patients' posture was adjusted so that the monitoring system equipment could be properly placed and fixed. The parameters were set similarly to the conventional EEG. A high-definition video camera was aimed at the patient, with the patient's head, face, limbs, and torso fully presented in the video interface. The patient's brain electrical activity was recorded during the asleep and awake states, with video synchronization capturing the patient's clinical performance during various periods of brain electrical activity. Induction tests, such as opening and closing eyes, flash stimulation, and hyperventilation, were conducted, and the brain's electrical activity was monitored during non-rapid eye movement and rapid eye movement periods. The detection time lasted not less than 12 hours, with some even lasting up to 24 hours. After the monitoring, the results were saved for playback and analysis.

2.3. Observation indicators

The diagnostic performance of video EEG and conventional EEG detection were evaluated, and the detection rates of epileptic discharges and clinical seizures of the two methods were compared. The standard for interpreting epileptic discharges involved identifying typical arrhythmia characteristics, including sharp waves, spikes, and slow waves. The criteria for assessing clinical seizures were based on the "Clinical Diagnosis and Treatment Guidelines: Epilepsy Volume."

Two senior neurologists, relying on medical history information and relevant clinical guidelines, conducted comprehensive interviews and reached clear diagnostic conclusions. These clinical, comprehensive diagnostic conclusions were considered the "gold standard." The cases were divided into "positive" (presence of abnormalities) and "negative" (normal). The diagnostic results of video EEG and conventional EEG tests were compared for the same cases, and the diagnostic accuracy, specificity, and sensitivity for each method were calculated. Lastly, the role of video electroencephalography in classifying post-stroke epilepsy was further analyzed.

In the "Clinical Diagnosis and Treatment Guidelines: Epilepsy Volume," epilepsy seizures are categorized into four types based on the patient's clinical manifestations. These include generalized seizures, partial seizures, partial seizures followed by generalized seizures, and seizures that cannot be classified.

2.4. Statistical methods

The patients' data were input into Excel and processed using SPSS 18.0. Measurement data were expressed as mean ± standard deviation and analyzed by a t-test. Count data were expressed as percentages and were analyzed using an χ^2-test. $\alpha = 0.05$ was used, with $P < 0.05$ indicating statistically significance.

3. Results

3.1. Diagnostic performance

The comprehensive clinical diagnosis conclusion showed that among 116 patients with suspected post-stroke epilepsy, a total of 64 cases were diagnosed. The specific results of video EEG and conventional EEG are shown in **Table 1**. The diagnostic accuracy, specificity, and sensitivity of video EEG were determined to be 92.24%, 94.23%, and 90.63%, respectively. These values were superior to those of conventional EEG, which were 64.66%, 76.92%, and 54.69%, respectively ($P < 0.05$).

Table 1. Comparison of diagnostic performance of two detection methods (cases)

Comprehensive clinical diagnosis	Video EEG		Conventional EEG		Total
	Positive	Negative	Positive	Negative	
Positive (n = 64)	58[a]	6[b]	35[a]	29[b]	64
Negative (n = 52)	3[c]	49[d]	12[c]	40[d]	52
Total	61	55	47	69	116

Note: [a]True positive, [b]false negative (missed diagnosis), [c]false positive (misdiagnosis), and [d]true negative.

3.2. Detection rates of epileptic discharges and clinical seizures

Among patients diagnosed with post-stroke epilepsy, the detection rate of epileptiform discharges and clinical seizures through video EEG was notably higher compared to conventional EEG ($P < 0.05$).

Table 2. Comparison of the detection rates of epileptic discharges and clinical seizures between two detection methods [cases (%)]

Detection method	*n*	Epileptic discharge	Clinical onset
Video EEG	64	49 (76.56)	40 (62.50)
Conventional EEG	64	21 (32.81)	22 (34.38)
χ^2	-	24.717	10.134
P	-	0.000	0.001

3.3. The role of video EEG in classifying post-stroke epilepsy

Among the clinical seizure cases identified by video EEG, six cases exhibited inconsistencies with the epilepsy classification in the comprehensive diagnostic conclusion. Specifically, five cases of generalized seizures were detected as partial seizures by video EEG, and one case that could not be classified was classified as a partial seizure by video EEG.

4. Discussion

During an epileptic seizure, abnormal brain electrical activity serves as a crucial reference for the clinical diagnosis of epilepsy. However, it is noteworthy that approximately 1% of healthy individuals may also exhibit epileptiform electrical activity [5,6]. Therefore, during the period between epileptic seizures, EEG alone cannot be relied upon as the exclusive diagnostic reference for epilepsy. Video EEG combines EEG technology with video monitoring capabilities, enabling the simultaneous recording of EEG in awake states, during natural sleep, and the awakening period. This is particularly advantageous as approximately 80% of epileptiform discharges tend to occur during sleep and complete sleep cycles, making it easier to track these discharges. Additionally, camera and video equipment are employed for real-time monitoring of the patient's seizure status. This approach proves beneficial in eliminating external interference factors, thereby facilitating the detection of more subtle forms of seizures [7-9]. The results of this study showed that video EEG's diagnostic accuracy, specificity, and sensitivity are significantly higher than those of conventional EEG. In patients with post-stroke epilepsy diagnosed, video EEG is more effective. The detection rate of epileptiform discharges and clinical seizures was also significantly higher than that of conventional EEG ($P < 0.05$). Therefore, it is suggested that video EEG detection is superior in the diagnosis of post-stroke epilepsy.

EEG represents a dynamic process of change, and meticulous observation of its evolution from the interictal period to the ictal period can provide valuable guidance in the classification and localization of epilepsy [10]. Among the clinical seizure cases detected by video EEG in this study, only 6 cases were inconsistent with the epilepsy classification by comprehensive diagnosis; 5 cases of generalized seizures were detected as partial seizures by video EEG, and 1 case that could not be classified was detected as partial seizures by video EEG. Video EEG detection can reflect the patient's seizure status and is an effective method for identifying epileptic and non-epileptic seizures. Nonetheless, the occurrence of alpha rhythm during epileptic seizures is often indicative of pseudoseizures. When evident clinical signs are documented during a seizure episode without accompanying epileptiform discharges, the diagnosis of non-epileptic seizures is confirmed. This underscores the significant clinical value of video EEG detection in determining the specific type of epilepsy following a stroke.

5. Conclusion

In summary, compared to conventional EEG, video EEG detection has higher diagnostic efficiency for post-stroke epilepsy and plays a significant role in determining the type of post-stroke epilepsy. Therefore, it should be widely applied in clinical practice.

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Disclosure statement

The author declares no conflict of interest.

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