ORIGINAL ARTICLE

The Value of Long-term Video EEG Monitoring to Diagnose and Track Childhood Epilepsy

How to Cite This Article: Mohammadi M, Shervin Badv R , Rezaei Z , Ashrafi M, Naeemi F . The Value of Long-term Video EEG Monitoring to Diagnose and Track Childhood Epilepsy. Iran J Child Neurol. Winter 2024; 18(1) :9-16

Mahmood MOHAMMADI MD[1],
Reza SHERVIN BADV MD [1],
Zahra REZAEI MD [1],
Mahmoodreza ASHRAFI MD [1],
Fatemeh NAEEMI MD [1]

1.Children Medical Center, Tehran University of Medical Sciences, Tehran, Iran

Corresponding Author
Naeemi f. MD
Epilepsy Monitoring Unit (EMU), Children Medical Center, Tehran University of Medical Sciences, Tehran, Iran
Email: f.naeemi82@gmail.com

Accepted: 06- Jan-2024
Received: 17-Aug-2023
Published: 18-Jan-2024

Abstract

Objectives: Long-term video-EEG monitoring (LTM) is a new technique to assess and track fluctuations, classify seizures, identify epileptic syndromes, and determine the number of seizures and epilepsy-simulating disorders. The present study aims to evaluate the concordance of traditional EEG and LTM in assessing childhood epilepsy.

Materials & Methods

This cross-sectional before-after study was performed on 120 children with epilepsy who were referred to the Epilepsy Monitoring Unit (EMU) at the Children's Medical Center between September 2021 and September 2022 and were monitored for at least eight hours in this unit. The source of the study information collection was the patients' recorded files. A neurologist reviewed the primary EEGs, and two experts blindly reviewed and interpreted the patients' LTMs under a clinical neurophysiologist's supervision.

Results

The diagnoses changed after employing LTM in most children with epilepsy. Based on the diagnostic agreement analysis between EEG and LTM, the coefficient value for LTM was calculated at -0.37 ($p = 0.229$), showing that LTM has significantly expanded patients' diagnoses and care plans.

Conclusion

The use of LTM improves the diagnosis, classification, and monitoring

of epilepsy in affected children and can be a reliable supplement to EEG in some instances.

Keywords: Long-term Monitoring, Epilepsy, Children
DOI: 10.22037/ijcn.v18i1.43012

Introduction

Diagnosing and treating epilepsy in children is still challenging. This disease financially burdens the patient's family and society and impacts their quality of life, specifically their participation in social activities (1). According to published statistics, the incidence of epilepsy in developing societies is significantly higher than that of industrialized societies. At the same time, the development of early disease detection technologies and the comprehensive management of this disease have been much faster in developed countries (2, 3). According to recent reports, the overall incidence of childhood epilepsy in developed Western countries has been estimated at 33 to 82 per 100.000, while this rate has ranged higher than 180 per 100.000 in developing countries (4). Of course, the occurrence of this complication is strongly dependent on age and has different occurrences at different ages (5). However, early diagnosis and accurate tracking and monitoring make it possible to manage this event properly, primarily in early childhood.

In assessing the diagnostic approaches for childhood epilepsy, although the evaluation of electroencephalogram (EEG) waves is the method of choice, it is not possible to examine the fluctuations and recurring episodes of this condition with EEG, leading to improper sensitivity and accuracy of this tool for the assessment of childhood epilepsy (6). Thus, long-term video-EEG monitoring (LTM) has been recently introduced as a new technique based on EEG. LTM is a specialized form of EEG performed by continuously monitoring the brain activity and video recording the clinical behaviors (7). The patient is hospitalized, and their brain waves and clinical images are recorded for several hours to several days for LTM. Hence, clinical symptoms and brain waves can be studied simultaneously (8). This examination is non-invasive, and the patient does not feel pain or discomfort during hospitalization. It also allows the doctor to measure the electrical activity of the patient's brain when the patient has abnormal behaviors or seizures to determine the nature of the seizure, the center of the seizure in the brain, and choose the best and most effective treatment method (medication or surgery) (9). LTM has been very effective in patients with frequent attacks whose definitive diagnosis is not possible with conventional methods. Using LTM in patients with epilepsy, the doctor can monitor the patient's 24-hour activities during sleeping and waking hours to determine the type and frequency of seizures (10). In addition, LTM helps the clinician determine the epileptic focus, distinguish between non-convulsive and convulsive seizures, classify seizures, identify epileptic syndromes, and determine the number of seizures and epilepsy-simulating disorders (11, 12).

Overall, analysis of LTM results during and between seizures provides detailed information on the function of brain areas (13). However, the usefulness of this method in evaluating children's convulsive attacks has been reported in a broad and contradictory range (between 19% and 75%) (14,15). As indicated recently by Ghazavi et al. (6), LTM, as a non-invasive diagnostic method, is a handy tool for differentiating epilepsy from conditions that mimic epilepsy. They showed that LTM is a very sensitive device in localizing the seizure focus in children with refractory epilepsy. In contrast, Goldstein et al. (16) in 2020 revealed that five days of EEG recording is optimal for detecting epileptiform abnormalities and seizures, while longer recordings have lower yields.

Additionally, this method has some potential limitations, including expensiveness, shortage of hospital beds, lack of access in all centers, the length of the intervention, and the need for a highly trained multidisciplinary team, including a clinical neurophysiologist, an experienced and trained nurse, an epileptologist, and a technician, as well as the need for expensive monitoring tools (17)—the present study aims to evaluate the concordance of traditional EEG and LTM in assessing childhood epilepsy.

Materials & Methods

This cross-sectional study was performed on children with epilepsy who were referred to the Epilepsy Monitoring Unit (EMU) at the Children's Medical Center between September 2021 and September 2022 and were monitored for at least eight hours in this unit. The current evaluation was classified into two periods: before using the LTM (September 2021 to March 2022) and after (April 2022 to September 2022). The source of the study information collection was the patient files in the EMU unit. To regularly collect information, a checklist consisting of age and sex, normal EEG findings, patient diagnosis before performing LTM, the reason for referral, clinical and neurophysiological findings of LTM, and the criteria for changing the diagnosis based on having or not having a diagnosis for epilepsy was completed by the researchers. Finally, patients' diagnoses before and after LTM were evaluated and reviewed. In this regard, the primary EEGs in all patients were reviewed by an expert, and the LTM of the patients was also blindly reviewed and interpreted by two neurologists under the supervision of a clinical neurophysiologist, and their information was recorded in the checklist. Patients with incomplete documentation were contacted by phone to fill in the missing information. Those who could not be reached or provide the information were excluded. The ultimate endpoint of this study was to compare the classical EEG methods and the LTM approach. The data were presented as numbers (%) for categorical parameters. The concordance between the two approaches was statistically evaluated by determining the Kappa value. The IBM SPSS software version 25.0 was used for statistical analysis. The p-value equal to or less than 0.05 was considered the significance level.

Results

In total, 120 children (74 male and 46 female) were assessed. The mean time length for LTM was 40.64±19.86 hours. Regarding the indications for LTM monitoring, seventy-two children had

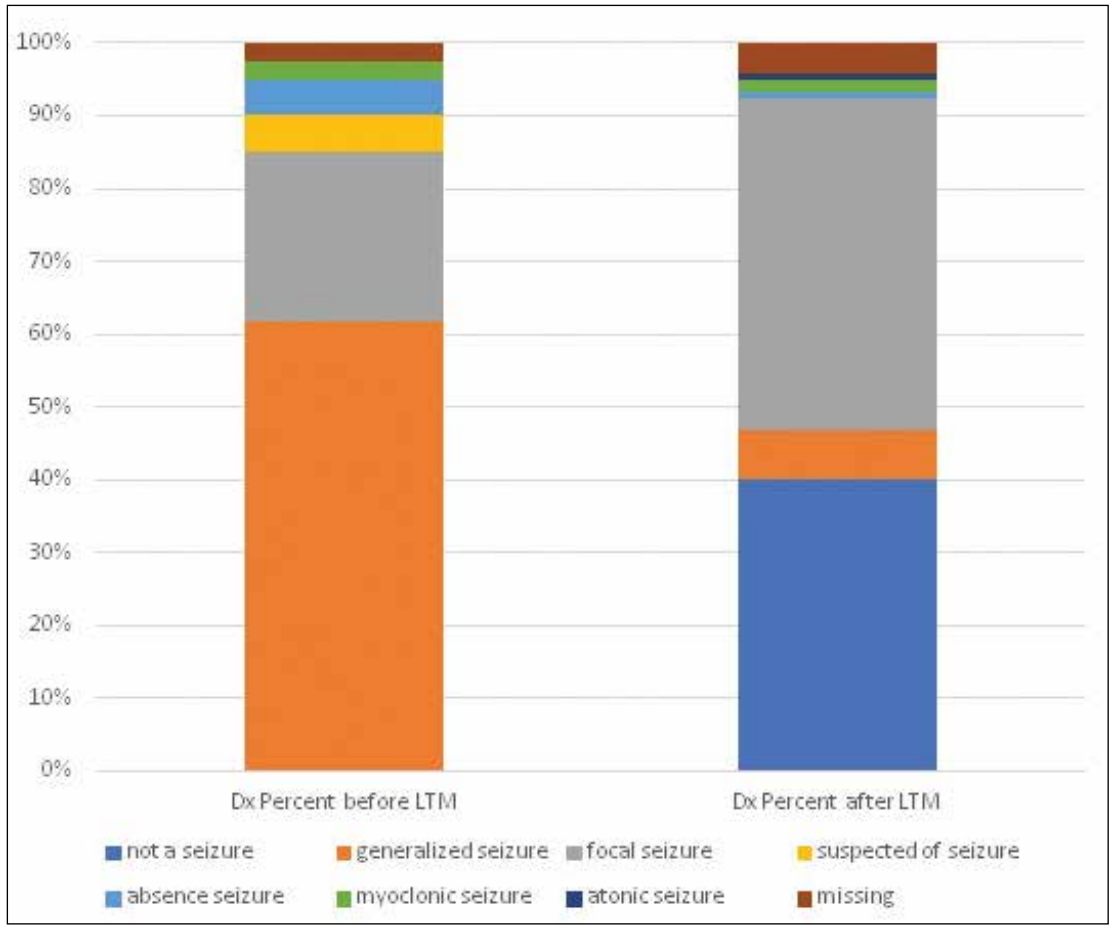

***Figure 1**: The diagnosis on patients before and after applying LTM*

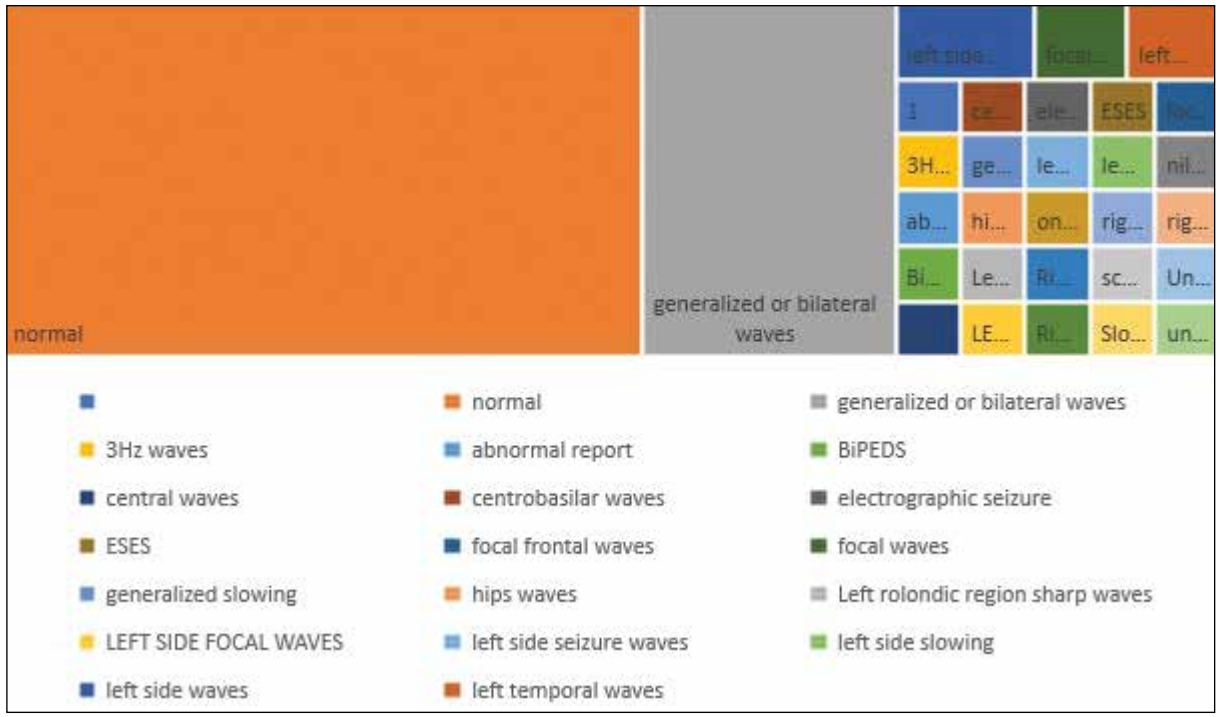

***Figure 2**: The frequency of LTM waves in the study population*

uncontrolled and treatment-resistant seizures; four were referred to localize the seizure before surgery, and forty-two to determine the nature of the seizures the child was experiencing (Figure 1). The most common initial diagnosis observed before LTM was generalized seizure (61.7%), followed by focal seizure (23.3%). The nature of seizure in the rest of the cases was unknown. The growth status was normal in seventy-eight patients (65%). However, thirty-five patients (29.2%) had a global developmental delay (GDD), and one patient had a mental disability. After performing LTM, less than half of the cases (40%, 48 patients) were confirmed to have no epileptic event. Overall, fifty-five patients (45.8%) had focal seizures. The diagnosis after LTM was absence seizure for one patient, myoclonic seizure for two patients, and atonic seizures for one patient. EEG findings were for sixty-six patients (55%). Generalized waves were observed in twenty-five patients (20.8%), and 19 had unilateral or focal waves. During LTM observation, seventy patients experienced only one seizure episode of one type, five patients had no episodes, and seven had multiple attacks. The localization was achieved for 115 patients. No epilepsy syndrome was diagnosed in sixty-five patients.

Furthermore, twenty-four people had frontal lobe epilepsy, and 13 people had Lennox-Gastaut syndrome. Epilepsy of the temporal lobe, occipital lobe, and mesofrontal lobe was recorded in only three, two, and one patient, respectively. In total, the changes in diagnosis after employing LTM occurred in most patients. Based on the diagnostic agreement analysis, Cohen's kappa coefficient value for LTM was calculated at -0.37 ($p = 0.229$), showing that LTM significantly improved patients' diagnoses and care plans.

Discussion

The current study aimed to investigate the files of patients referred to the LTM department at the Children's Medical Center and assess the results of the LTMs and their impact on clinical decisions in children suffering from epilepsy-like disorders. It is now clear that the correct and early diagnosis of epilepsy is essential and can help schedule the best treatment plan and prevent wrong or unnecessary treatments. After the correct diagnosis of epilepsy, it is essential to distinguish the type of seizure and epilepsy and the diagnosis of epilepsy syndrome for the proper management of the patient. Employing LTM is a crucial diagnostic approach to achieve this goal, and its use has gained a special place, specifically in recent years. LTM is the best diagnostic tool for patients with seizures or seizure-like behavioral events. As shown in the present study, this technique led to a significant change in the diagnostic findings regarding epilepsy in children, which resulted in a shift in the management approaches of these patients. In this study, after performing LTM, the diagnosis of any epilepsy was rejected for many of these patients, and finally, forty-eight patients (40%) were considered to have no seizures. In Alving et al.'s study, an ictal event was recorded in 83% of LTM sessions, and in 17% of cases, it was also recorded during the task before LTM. In their study, no definite and clinically relevant conclusion/decision can be made in 22% of patients. Thus, by their definition, LTM was useful in 44% of cases (18).

Employing the LTM protocol can lead to the

discontinuation of medications in many patients who previously had a definitive diagnosis of epilepsy based on conventional and cross-sectional EEG. In a study by Ghazavi et al. (6), following the use of the LTM protocol, 6.9% were diagnosed with pseudoseizures that suggested stopping the medication. Moreover, 19.7% were referred for invasive monitoring. In another study, 454 patients in the age range of 11 days to 20 years were studied using LTM. In total, 23.6% and 24.9% of patients were diagnosed with general or partial seizures, respectively. While 35% had pseudoseizures for which it was recommended to discontinue antiepileptic medications, and 2% were referred for aggressive monitoring. Therefore, evidently, implementing this protocol can lead to the reduction of cases requiring medication treatment or even aggressive treatments to control seizures in children, and it could reduce medication significantly. Of course, the precise definition of the indications for the referral of patients for LTM and patient autonomy should also be considered in implementing this technique. In this regard, the diagnosis of epilepsy based on LTM ranged widely from 14% to 90% (19-22). One of the most important indications for using this technique has been the decision to perform surgery on patients (23, 24). Recently, a multicenter evaluation of the role of LTM in decision-making in TLE surgery showed that converging MRI with long-term interictal and ictal EEG findings correctly identified candidates eligible for surgery (25).

The important point in using this technique is the change in the patient treatment approach. This change was also observed in most patients in the present study. LTM has similarly led to a change in diagnosis in 58% of patients in Ghougassian et al.'s (26) study and 37.5% in Catrin Mann et al.'s study (27). This change in treatment was either a change in medication treatment according to the type of epilepsy and epilepsy syndrome, the discontinuation of the treatment in a patient who was determined not to have epilepsy according to LTM who was previously diagnosed with epilepsy, or switching from medication treatment to surgical treatment as shown in 53% of patients in Kumar-Pelayo et al. study (28).

The study had some potential limitations. First, the study was single-centered. In other words, all sampling was done in the medical center due to its referral role and centrality. Furthermore, the available sampling method and the non-randomness of the samples may lead to errors. Thus, the sampling was conducted in non-consecutive and random weeks, which somewhat solved this problem. One of the study's significant limitations was the existence of some defects in the patients' files, which did not lead to the desired results with the patients' follow-ups. Insufficient time due to different issues, the most important of which may be the inability to pay the necessary expenses, was another limitation of this study.

In Conclusion

LTM is a valuable diagnostic tool even in a carefully selected patient population that has been extensively studied before monitoring. In addition, the follow-up process of the patients should be recorded in their LTM file at each visit so that it can help in their treatment process and be used in research works, which will ultimately improve the treatment of patients with epilepsy and similar

events. Seemingly, the follow-up clinic for LTM patients should be established actively and regularly. Therefore, it is strongly recommended to form and organize data in a database for data mining.

Acknowledgment

The authors are grateful to the participants and their family. This study is confirmed by ethics code IR.TUMC.CHMC. REC. 1401, 152 in Tehran university of medical sciences.

Author's contribution

MM design the study and supervised the study performance, RS and ZR collected the data, MA analyzed the data, FM drafted the manuscript and follow the data gathering

Conflict of interest

The authors have no conflict of interest

References

1. Perucca P, Scheffer IE, Kiley M. The management of epilepsy in children and adults. Med J Aust 2018;208(5):226-33.
2. Camfield P, Camfield C. Incidence, prevalence and aetiology of seizures and epilepsy in children. Epileptic Disor. 2015;17(2):117-23.
3. Fine A, Wirrell EC. Seizures in Children. Pediatr Rev 2020;41(7):321-47.
4. Beghi E. The Epidemiology of Epilepsy. Neuroepidemiology 2020;54(2):185-91.
5. Symonds JD, Elliott KS, Shetty J, Armstrong M, Brunklaus A, Cutcutache I, et al. Early childhood epilepsies: epidemiology, classification, aetiology, and socio-economic determinants. Brain 2021;144(9):2879-91.
6. Ghazavi Y, Zarchi EA, Taheri T, Safiabadi M, Rahimian E, Amirsalari S. Long-term Video-EEG Monitoring Findings in Children and Adolescents with Intractable Epilepsy. Iran J Child Neurol 2017;11(4):23-31.
7. Patel AD, Haridas B, Grinspan ZM, Stevens J. Utility of long-term video-EEG monitoring for children with staring. Epilepsy Behav 2017;68:186-91.
8. Kobulashvili T, Höfler J, Dobesberger J, Ernst F, Ryvlin P, Cross JH, et al. Current practices in long-term video-EEG monitoring services: A survey among partners of the E-PILEPSY pilot network of reference for refractory epilepsy and epilepsy surgery. Seizure 2016;38:38-45.
9. Cox FM, Reus EE, Visser GH. Timing of first event in inpatient long-term video-EEG monitoring for diagnostic purposes. Epilepsy Res 2017;129:91-94.
10. van Griethuysen R, van Asch CJJ, Otte WM, Sander JW, Braun KPJ. Yield and risk associated with prolonged presurgical video-EEG monitoring: a systematic review. Epileptic Disord 2022;24(6):1033-45.
11. Aslan M, Gungor S. The Importance of Long-Term Video Electroencephalography Monitoring in the Differential Diagnosis of Epilepsy in Children. Cureus 2022;14(6):25700.
12. Mann C, Willems LM, Leyer AC, Freiman TM, Konczalla J, Kieslich M, et al. Benefits, safety and outcomes of long-term video EEG monitoring in pediatric patients. Eur J Paediatr Neurol 2021;32:29-35.
13. Kobulashvili T, Kuchukhidze G, Brigo F, Zimmermann G, Höfler J, Leitinger M, et al

Diagnostic and prognostic value of noninvasive long-term video-electroencephalographic monitoring in epilepsy surgery: A systematic review and meta-analysis from the E-PILEPSY consortium. Epilepsia 2018;59(12):2272-83.

14. Shih JJ, Fountain NB, Herman ST, Bagic A, Lado F, Arnold S, et al. Indications and methodology for video-electroencephalographic studies in the epilepsy monitoring unit. Epilepsia 2018;59(1):27-36.
15. Montavont A, Kaminska A, Soufflet C, Taussig D. Long-term EEG in children. Neurophysiol Clin 2015 Mar;45(1):81-5.
16. Alix JJ, Kandler RH, Mordekar SR. The value of long term EEG monitoring in children: a comparison of ambulatory EEG and video telemetry. Seizure 2014;23(8):662-5.
17. Alving J, Beniczky S. Diagnostic usefulness and duration of the inpatient long-term video-EEG monitoring: findings in patients extensively investigated before the monitoring. Seizure 2009;18(7):470-3.
18. Hazavi Y, Zarchi EA, Taheri T, Safiabadi M, Rahimian E, Amirsalari S. Long-term Video-EEG Monitoring Findings in Children and Adolescents with Intractable Epilepsy. Iran J Child Neurol 2017;11(4):23.
19. Arrington DK, Ng Y-T, Troester MM, Kerrigan JF, Chapman KE. Utility and safety of prolonged video-EEG monitoring in a tertiary pediatric epilepsy monitoring unit. Epilepsy Behav 2013;27(2):346-50.
20. Mann C, Willems LM, Leyer A-C, Freiman TM, Konczalla J, Kieslich M, et al. Benefits, safety and outcomes of long-term video EEG monitoring in pediatric patients. Eur J Paediatr Neurol 2021;32:29-35.
21. Mohan K, Markand O, Salanov V. Diagnostic utility of video EEG monitoring in paroxysmal events. Acta Neurologica Scandinavica 1996;94(5):320-5.
22. Uijl SG, Leijten FS, Arends JB, Parra J, van Huffelen AC, Moons KG. Decision-making in temporal lobe epilepsy surgery: the contribution of basic non-invasive tests. Seizure 2008;17(4):364-73.
23. Boon P, Michielsen G, Goossens L, Drieghe C, D'Have M, Buyle M, et al. Interictal and ictal video-EEG monitoring. Acta Neurologica Belgica 1999;99(4):247-55
24. Ghougassian DF, d'Souza W, Cook MJ, O'Brien TJ. Evaluating the utility of inpatient video-EEG monitoring. Epilepsia 2004;45(8):928-32.
25. Kumar-Pelayo M, Oller-Cramsie M, Mihu N, Harden C. Utility of video-EEG monitoring in a tertiary care epilepsy center. Epilepsy Behav 2013;28(3):501-3.