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The Role of Video Electroencephalography and Neuropsychological Activation Protocol in the Classification of Epilepsy

A Thesis

Submitted to the Council of College of Medicine, University of Babylon in Partial Fulfillment of the Requirements for the Degree of Master Degree in Science/Medical Physiology

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Supervisors' Certification

We certify that this thesis was prepared under our supervision at Babylon Collage of Medicine as a partial fulfillment of the requirements for the degree of Master of science in Medical physiology.

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According to the available recommendations, I forward this thesis for debate by the examining committee.

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

" أَنزَلَ مِنَ السَّمَاء مَاء فَسَالَتْ أَوْدِيَةٌ بِقَدَرِهَا فَاحْتَمَلَ السَّيْلُ زَبَدًا رَّابِيًا وَمِمَّا يُوقِدُونَ عَلَيْهِ فِي النَّارِ ابْتِغَاء حِلْيَةٍ أَوْ مَتَاعٍ زَبَدٌ مِّثْلُهُ كَذَلِكَ يَضْرِبُ اللَّهُ الْحَقَّ وَالْبَاطِلَ فأَمَا الزَّبَدُ فَيَذْهَبُ جُفَاءً وَأَمَّا مَا يَنْفَعُ النَّاسَ فَيَمْكُثُ فِي الْأَرْضِ كَذَلِكَ يَضْرِبُ اللَّهُ الأَمْثَالَ"

صدق الله العلي العظيم

سورة الرعد (آية 17)

Dedication

to my father and mother... Thanks and gratitude

To my dear husband, Ameer, with love and loyalty

To Mariam, my lovely daughter

Burak

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Praise be to Allah,

I am grateful to my supervisor, Asst. Prof. Dr. Zahid Mohammed Ali Kadhim, for giving me support and confidence and guide me to complete my thesis. I am also grateful to my professors in the college of medicine in general and in the Department of Medical Physiology in particular for the great scientific support and guidance they gave me.

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Summary

Epilepsy, one of the most common chronic neurological disorders, affects about 50 million people in the world. It's diagnosed clinically based on seizure semiology and also the findings of electroencephalographic recording. Routine electroencephalography sometimes fails to record interictal epileptic discharge in some patients, especially the elderly and those with focal seizures, so video electroencephalography represents the gold-standard tool for diagnosis upon routine electroencephalography, with the use of provocative methods to increase the yield of interictal discharge induction such as hyperventilation, intermittent photic stimulation, and sleep deprivation. Neuropsychological activation protocol is a protocol recently used to induce cortical activation for evoking interictal discharges by a variety of cognitive tasks like reading, writing, mathematics, drawing, and spatial construction.

The aims of present study are to test the usefulness of video electroencephalographic monitoring in the classification of seizures and investigate the effectiveness of neuropsychological activation protocols in inducing epileptiform discharges.

This is a cross-sectional study conducted in the neurology ward/ video electroencephalographic room in Al-Imam Al-Sadiq Teaching hospital in Al-Hillah city during the period from September 2022 until April 2023. The study included 47 patients with age distribution between 12 to 52 years (25 males and 22 females). Patients are recruited from the video electroencephalographic room in the neurology ward after being diagnosed to have epilepsy by an experienced neurologist. All entrants, after taking verbal permission, undergo a thorough clinical evaluation with a focus on neurological assessment done by neurologist, then undergo video

electroencephalography recording in different phases like eye closed, eye opened, hyperventilation, intermittent photic stimulation, and neuropsychological activation protocol, followed by sleep electroencephalography if possible. Recording continued for 2 to 6 hours, and then analysis of electroencephalography recordings along with video recordings was done by an experienced clinical neurophysiologist who was blind to patient history and provisional diagnosis.

This study revealed that the percentage of patients who had interictal discharges through video recording electroencephalography was approximately 91.48%, with more results, classification of seizures according to the International League Against Epilepsy-2017 into focal seizures (11 patients) and generalized onset seizures (36 patients) and their subtypes, the generalized onset seizure (motor, tonic-clonic) appears to be the most common type in the study. Video electroencephalography monitoring participated in changing the initial diagnosis of seizure type in 27 patients (57.45%). Also, six participants (12.6%) developed an ictal state at different stages of recording. The neuropsychological activation protocol induces interictal discharges in about 72.3% of patients, while mathematics (written calculation) is considered the most common technique that induces epileptiform discharges (29.78%).

According to study results we conclude that, video electroencephalography represents a cornerstone in the diagnosis and classification of epilepsy syndromes, that it helps in choosing appropriate treatment and improving the prognosis of seizures, and that it helps in altering the diagnosis of epilepsy type and setting a definitive diagnosis based on video recording and seizure semiology. The neuropsychological activation protocol is considered an important part of provoking interictal discharges, especially in focal seizures, and may induce seizure attacks

during recording, so it may represent a useful tool in triggering interictal discharges that have important role in the diagnosis and classification of epilepsy syndromes.

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List of abbreviations

abbreviation	Definition
EEG	Electroencephalography
NPA	Neuropsychological activation protocol
ILAE	International league against epilepsy
IEDs	Interictal discharges
GTC	Generalized tonic clonic
CAE	Childhood absence epilepsy
JME	Juvenile Myoclonic epilepsy
JAE	Juvenile absence epilepsy
EMU	Epilepsy monitoring unit
ICU	Intensive care unit
GABA	Gamma-aminobutyric acid
MRI	Magnetic resonance imaging

CT	computerized tomography
CSF	Cerebrospinal fluid
Hz	Hertz
AED	Antiepileptic Drugs

CHAPTER ONE

INTRODUCTION

Chapter 1

Introduction

1.1. Introduction

Epilepsy is a common neurological disease that affects over 50 million people globally, with the majority of people who suffer from it living in low- and middle-income countries(Saxena & Li, 2017).

Epilepsy can affect people of all ages, ethnic backgrounds, and cultures, regardless of their geographical location. It is estimated that one-third of people with epilepsy are uncontrolled by antiseizure medication (Beghi, 2020).

Patients with untreated seizure, which are episodes of repeated seizures, can experience a significant impact on their quality of life, they may have difficulty performing everyday tasks, such as driving or working, and may also experience social isolation and psychological distress, in addition, untreated seizure clusters can increase the risk of developing status epilepticus, a life-threatening condition characterized by prolonged and continuous seizures, this can lead to emergency room visits and hospitalizations, as well as increased morbidity and mortality(B. Chen *et al*., 2017).

New classification of seizures which has been proposed by the "International League Against Epilepsy" (ILAE) in 2017, "ILAE" stated a classification of seizures according to the onset of the seizure (Fikrat Alwindawi *et al*., 2020), epilepsy is typically divided into three subtypes, generalized onset seizure , focal onset seizure , focal to bilateral tonic clonic seizure (Christie *et al*., 2021).

The diagnosis of epilepsy is typically made on the basis of a thorough history and a routine encephalography (EEG), and it's possible to initial EEG fails to show epileptiform discharge that's reach to more than 40% of patients, so video EEG monitoring is considered gold standard for assessment of semiological and EEG change of seizures(Dobesberger *et al*., 2015), because it establish the diagnosis of epilepsy in most cases(Alsaadi *et al*., 2004), video EEG includes recording EEG data for long time from hours to days assisted by video recording in the hope of inducting the ictal event or capturing the interictal epileptiform abnormalities that help in deciding the presence of seizure and its classification(De Marchi *et al*., 2017), also it plays an essential role in presurgical assessment of patients with drug resistant epilepsy, to increase the likelihood of capturing seizures during the video EEG monitoring, provocative procedures may be used with it, such as sleep deprivation, hyperventilation, and anti-seizure medicine withdrawal(Baheti *et al*., 2021).

Seizures can be triggered by a variety of factors, including lacking sleep, sudden awakening, tiredness, alcohol intake, flashing lights, menstruation, and stress, in addition to these factors there are complex cognitive activities can also precipitate seizures in some individuals with epilepsy, these activities may include tasks that require a significant mental effort or concentration, cognitive activities such as calculations, writing, reading, drawing, and playing board games(Miyoklonik & Hastalarında, 2013).

Many researchers investigated the use of certain protocols that proposed to cause cortical activation hoping to induce the epileptiform abnormalities, procedures like reading, talking, writing and solving mathematical tasks are all incorporated to activate the cortical neurons and then epileptic discharges (Gelžiniene *et al*., 2015). A neuropsychological activation protocol (NPA) can include a variety of tasks and tests designed to evaluate cognitive functioning, including reading, speaking, mental

and written calculation, writing, and spatial construction used during EEG recording to measure electrical activity in the brain during the performance of these tasks(Wolf, 2014), the use of neuropsychological activation protocol can be a valuable tool in the assessment and management of epilepsy, particularly in identifying specific seizure patterns associated with different types of epileptic syndromes(Guaranha *et al*., 2009).

1.2. Aims of study

The aims of the study are :

1. Test the usefulness of video electroencephalographic monitoring in the classification of seizures.
2. Investigate the effectiveness of neuropsychological activation protocols as activation procedure in inducing epileptiform discharges.

CHAPTER TWO

REVIEW OF LITERATURE

Chapter 2

Review of literature

2.1 Epilepsy

Definition: there are many definitions for epilepsy set by different organizations, authors and scientists, but the most widely used one is that proposed by the international league against epilepsy (ILAE) in 2017 which introduces two definitions,

A. Conceptual definition:

"Epilepsy is a disorder of brain characterized by an enduring Predisposition to generate epileptic seizures, and by the neurobiologic, cognitive, psychological, and social consequences of this condition. The definition of epilepsy requires the occurrence of at least one epileptic seizure (Brissart *et al*., 2019).

B. Operational (practical) or clinical definition of epilepsy:

epilepsy is defined when an individual has:

1. at least two unprovoked or reflex seizures >24 hours apart,

2.one unprovoked or reflex seizure and a probability of having another seizure similar to the general recurrence risk after two unprovoked seizures (≥60%) over the next10 years,

3. an epilepsy syndrome(Falco-walter *et al*.,2017).

While epileptic seizure is defined as "a transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal

activity in the brain", this definition implies that seizures are self-limited (Trinka *et al*., 2015).

Epilepsy is characterized by unusual electrical activity in the brain that leads to abnormal motor activity, sensation, consciousness or behavior, it is regarded as one of the most common neurological illnesses that can affect the life adjustment and affects the physical and psychological functions of the affected individual (Mehvari Habibabadi *et al*., 2021).

Despite advances in the management of epilepsy, 30–40% of epileptic patients have uncontrollable seizures that increase morbidity and mortality, and named drug-resistant or intractable epilepsy which is defined as failure of adequate trials of two tolerated, appropriately chosen and used antiepileptic drug schedules (whether as monotherapies or in combination) to achieve sustained seizure freedom (Bosak *et al*., 2019).

2.1.1 Prevalence

Epilepsy is one of the most common chronic neurological disorders, it has no age, race, social class or geographical boundaries, and approximately 50 million people worldwide with epilepsy, accounting for 0.5% of the total disease burden in global population (WHO.,2010).

It is estimated that nearly half of the global population with epilepsy lives in Asian countries, and epilepsy has been estimated to affect about 23 million people in Asia, with prevalence of epilepsy was 700 per 100,000 globally while the rates in Asia reported to be 1.5 and 14.0 per 1000 person (Lee *et al* ., 2022).

Also, epilepsy is considered the second cause of neurological diseases in the world, and prevalence of epilepsy in different countries is stated to be 4–10 per 1000 individual (Mehvari Habibabadi *et al.*, 2021).

The risk of a single seizure occurring during the lifespan in the general population is 5–10%, and approximately 3% of them may meet the criteria of epilepsy (T. Chen *et al.*, 2016).

There is no international data that describes the prevalence of epilepsy in Iraq, but several studies are made to decipher that like a study done by Hussain & Lafta (2019), who recorded a prevalence of epilepsy to be nearly 21.74/1000 at the period from 2000 to 2016. Another research conducted at Irbil found that the prevalence is about 9.7/1000 population (Khidr *et al.*, 2011).

Epilepsy has a bimodal age distribution, very young and elderly ages. In the same direction, it is expected that as life expectancy increases and the population ages, there will be an escalating number of older adults with epilepsy requiring ongoing care, diagnosis and management. Also, epilepsy in older individuals is complicated by a broad range of medical comorbidities and differential diagnoses. Common conditions often misdiagnosed as epileptic seizures in older adults include syncope, transient ischemic attack, transient global amnesia, complex migraine, and confusional episodes (Hew *et al.*, 2021).

Epilepsy can negatively impact many aspects of a person's life (Idris *et al.*, 2021), in spite of development and availability of many antiepileptic medications, around 33% of the affected people still suffer from regular seizures (Neufeld *et al.*, 2016).

2.1.2 Epilepsy classifications:

Classification of seizure and epilepsy syndrome is important step in care and management of patients. This classification is needed due to the wide diversity in seizure types and epileptic disorders (Shlobin *et al.*, 2021). Multiple classification schemes are proposed, however that introduced by ILAE is the most widely accepted one.

2.1.2.1 Current ILAE classifications:

In 2017 the International League Against Epilepsy releases the latest classification scheme called the revised classification of seizure types as well as epilepsy syndromes (Varnado *et al*., 2020), figure (2-1).

This new classification improves the understanding of seizure types as well as of seizure triggers, prognosis, and comorbidity risks, also serving as a guide to select the best antiepileptic therapy (de Corrêa *et al.*, 2022).

The Clinical features of the seizure onset and evolution (ictal and immediate postictal semiology) can provide valuable information about seizure type and location of the epileptogenic zone, and so they are used as a basic scheme for this new classification. The ILAE revised classification 2017 depend greatly on semiological parameters to classify seizures into generalized onset, focal onset or unknown onset seizure (Lüders *et al.*, 2019).

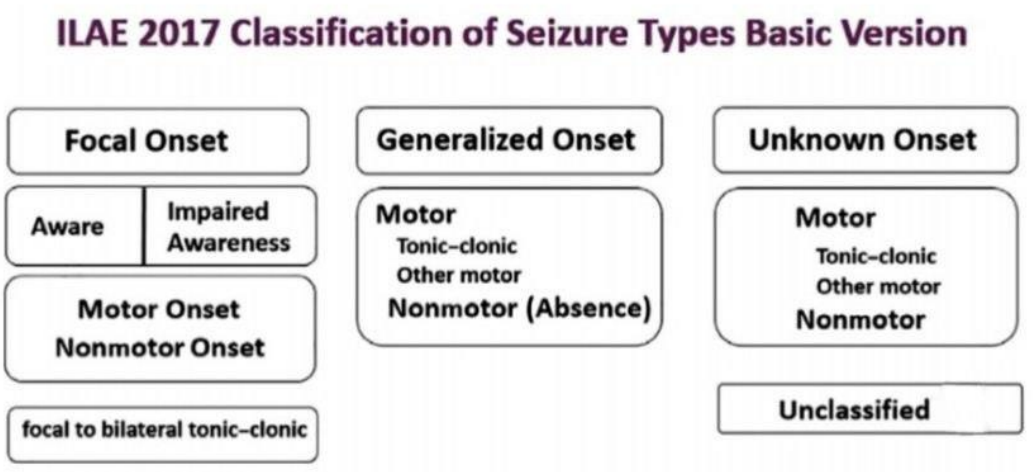


Figure (2-1): Basic ILAE-2017 classification of seizures types (Varnado *et al*., 2020).

2.1.2.1.1. Focal onset seizures

Focal seizures arise from a neuronal network either discretely localized within one cerebral hemisphere or more broadly distributed but still within the same hemisphere. With the new classification system, the subcategories of "simple focal seizures" replaced by focal aware seizure (Hauser *et al*., 2013), and all seizures with any impairment of consciousness during the course of the seizure are classified as "focal seizure with impaired awareness" a term that corresponds to the old term "complex partial seizure"(Rosenow *et al*., 2020), and focal seizures subsequently evolve into generalized seizures, in the past this was referred to as focal seizures with secondary generalization, but the new system uses the term focal to bilateral tonic clonic seizure(Chang *et al*., 2017), focal epilepsies account for about two-thirds of all adult epilepsy patients, and temporal lobe epilepsy is the most common type of focal epilepsy (Asadi-pooya *et*

al., 2015), while frontal lobe epilepsy is the second most common type of focal epilepsies (Ljunggren *et al*., 2015).

2.1.2.1.2. Generalized Onset Seizures

A generalized seizure is defined as one that originates at some point and rapidly engages bilaterally distributed networks to affect both hemispheres, generalized-onset seizures are divided into motor and nonmotor (absence) seizures, and level of awareness is not used as a classifier for generalized seizures, since the large majority of generalized seizures are associated with impaired awareness (Fisher *et al*., 2017).

Generalized seizure types includes, absence, myoclonic, tonic–clonic, and myoclonic– tonic– clonic seizures (Hirsch *et al*., 2022).

2.1.2.1.3 Unknown Onset Seizures:

The term "unknown onset" used if semiology and investigations does not allow classification into focal or generalized onset, and additional features, including motor, nonmotor, tonic–clonic, epileptic spasms, and behavior arrest can be described as possible, frequently, seizures falling into this category will later be re-classified into focal or generalized onset following further diagnostic studies or clinical data (Cascino *et al*., 2021).

2.1.3 Pathophysiology of seizures:

Seizures are occurring due to an imbalance between brain excitation and inhibition, governed by the main stimulant neurotransmitter glutamate, and the main suppressor neurotransmitter gamma-aminobutyric acid (GABA), which leads to a sudden neuronal hyper excitability and hyper

synchronized electrical brain activity, as well as neurobiological, cognitive, psychological and social consequences (García-Rodríguez *et al*., 2022).

2.1.4 Causes of Seizures

It is important to identify the etiology of a seizure for both treatment and prognostication (Sazgar *et al*., 2019), there are multiple causes or etiologies for seizure as shown next:

1. Genetic cause:

Approximately 15% of people with epilepsy have a positive family history (first-degree relative with epilepsy) and risk of epilepsy is about threefold higher if a first-degree relative has epilepsy (Sazgar *et al*., 2019), the epilepsies in which a genetic etiology has been implicated are relatively varied and, in most cases, the underlying genes are not yet known (Scheffer *et al*., 2017).

2. Head Trauma

Head trauma is a common cause of epilepsy, particularly when it is associated with a depressed skull fracture or intracerebral or subdural hematoma, seizures that occur within the first week after non penetrating head injuries are not predictive of a chronic seizure disorder, however, although patients with serious head injuries are often treated prophylactically with anticonvulsant drugs, a resultant reduction in the incidence of posttraumatic seizures in patients so treated has not been consistently observed (Greenberg *et al*., 2018).

2. Metabolic

A metabolic etiology is defined when a patient has a documented metabolic condition associated with a substantially increased risk of developing epilepsy. Examples include glucose transporter deficiency, creatinine deficiency syndromes or mitochondrial cytopathies, many of these conditions are genetically inherited – in such cases, the term metabolic-genetic etiology should be used (Cascino *et al.*,2021).

4. Structural

A structural etiology refers to abnormalities visible on structural neuroimaging where the electroclinical assessment together with the imaging findings lead to a reasonable inference that the imaging abnormality is the likely cause of the patient's seizures, structural etiologies may be acquired such as stroke, trauma, or genetic such as many malformations of cortical development, identification of a subtle structural lesion requires appropriate MRI studies (Scheffer *et al.*, 2017).

5. CNS Infections

Infectious etiologies are more prevalent in developing nations, in infectious etiology implies that epilepsy and seizures are main symptoms of the disorder, and examples include neurocysticercosis, human immunodeficiency virus, cerebral malaria, or congenital infections such as Zika virus or cytomegalovirus, infectious etiology should not be used to describe acute symptomatic seizures that occur during brain infection, such as encephalitis or meningitis (Lewis *et al.*, 2022)**.**

6. Autoimmune epilepsy:

Epilepsy affects approximately 0.5% to 1.0% of the world's population, over the last few decades, multiple neural autoantibodies targeting cell surface or intracellular antigens associated with epilepsy and/or encephalopathy have been discovered, identification of immune-mediated epilepsy is critical as early initiation of immunotherapy has been associated with favorable clinical outcome, diagnosis of autoimmune epilepsy, in majority of the cases, is based on their clinical characteristics, magnetic resonance imaging (MRI) results, and cerebrospinal fluid (CSF) analysis (Husari *et al* ., 2019).

2.1.5 Diagnosis of epilepsy:

The diagnosis of epilepsy in general is a clinical one and is typically based on detailed history that describes precisely the ictal and peri-ictal semiology, it is also very useful to have history from patient family or caregiver and utilizing any video recording of the ictal event to help in the correct diagnosis and help to characterize the type of epilepsy (Amin *et al* ., 2019).

There are multiple tools and diagnostic procedures that help in the diagnosis and exclude seizure mimics and to help in categorization of seizure type like (H. U. Amin *et al*., 2020),

1. Neuroimaging is an essential part of the epilepsy workup such as computed tomography (CT) and magnetic resonance imaging (MRI), mainly useful for the identification of acute brain (intracerebral hemorrhage, subarachnoid hemorrhage, subdural/epidural hematoma,

etc.), and may also detect subacute/ chronic stroke, large tumors, and calcified neurocysticercosis (Sazgar *et al*., 2019).

2. The electroencephalogram (EEG) commonly detects seizure activity as it reflects electrophysiological conditions of the brain at a given time (H. U. Amin et al., 2020), and seizure semiology can help determine the hemisphere and lobe of seizure onset, to characterize a patient's habitual seizures, often required video EEG to captured seizures attack (Kinney *et al*., 2019).

2.2 Electroencephalography

Is the recording of electrical activity of the brain using electrodes that attaches to the skull surface non-invasively. German neuropsychiatric from Jena, Hans Berger (1873-1941) was the one who discovered the electroencephalography (EEG), and the first human EEG record was done on a 17-year-old boy during neurosurgical operation (Mecarelli *et al*., 2019).

Electroencephalography remains as an essential non-invasive method for analyzing electrophysiological brain activity in epilepsy and in selected disorders of brain dysfunction. Although the practical definition of epilepsy is clinical, scalp EEG has an essential role not only in the diagnosis of epilepsy, but also in the follow-up if the disease evolves, and in the classification and management of seizure types and epilepsy syndromes (Peltola *et al*., 2023).

A local current is generated when neurons in the brain are activated during synaptic excitations of the dendrites, the differences of electrical potentials are caused by summed postsynaptic graded potentials from

pyramidal cells that create electrical dipoles between soma and apical dendrites that causes EEG waves (Beniczky & Schomer, 2020).

Routine EEG continuous 20–30 minutes, usually without video, often fails to show epileptiform activity, because the manifestations of epilepsy are brief and intermittent (Tatum *et al*., 2022), the sensitivity of a routine EEG after a first unprovoked seizure is limited, ranging from 25 to 50% and 45% for second routine EEG (Geut *et al*., 2017), the recordings should include periods when the eyes are open and when they are closed, as well as adequate provocative maneuvers(Beniczky & Schomer, 2020).

2.2.1 Frequency bands

Electrical recordings from the outer surface of the brain demonstrate that there is continuous electrical activity in the brain. Both the intensity and the patterns of this electrical activity are determined by the level of excitation of different parts of the brain resulting from sleep, wakefulness, or brain disorders such as epilepsy or even psychoses. Brain waves, shown in figure (2-2), are the undulations in recorded electrical potentials (Guyton, 2016).

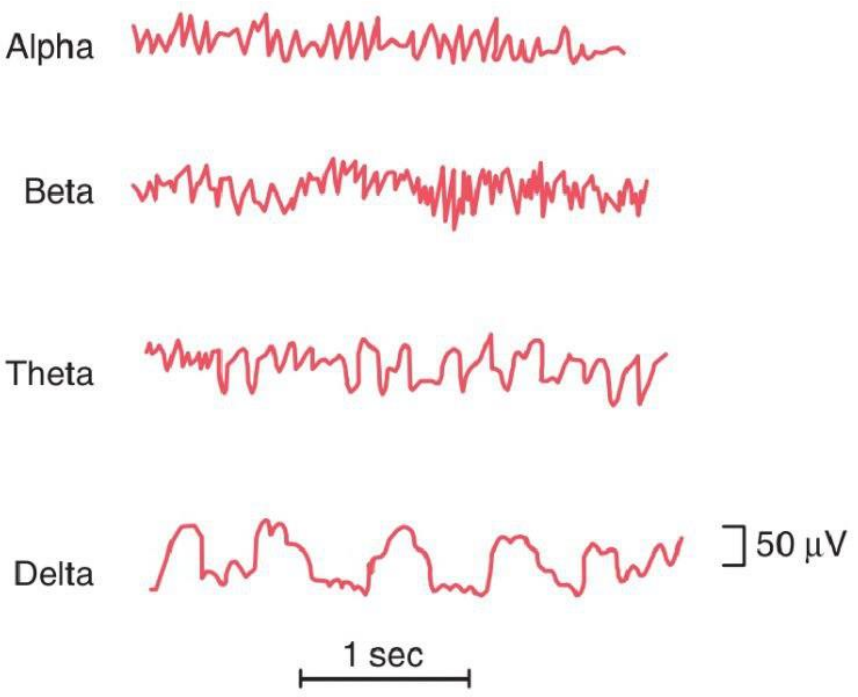


Figure (2-2): normal brain waves (Guyton, 2016).

The EEG waveforms are generally classified according to their frequency, amplitude, shape as well as position of the electrodes on the scalp. Frequency (Hertz, Hz) is the basic unit used to determine frequency bands into waveforms such as, alpha, beta, theta, delta and gamma. Certain pattern of the waveforms is normal at specific age, state of alertness and sleep, and brain wave frequency differs corresponds to different behavior and mental states of the brain (Kumar *et al*., 2012).

1. Alpha rhythm

It represents the starting point to analyze clinical EEG, in the normal EEG alpha rhythm has following features:

- it’s distributed maximally in the occipital regions so it’s termed as posterior dominant rhythm and it’s represented bilaterally

- lies within the 8-13 Hz band width (alpha frequency).

- is attenuated with eye opening.

-appear during relaxed wakefulness and disappear by drowsiness and sleep.

During normal development, an 8-Hz alpha frequency appears by 3 years of age and the alpha rhythm remains stable between 8 and 12 Hz even during normal aging into the later years of life (Feyissa *et al*., 2019).

2. Beta rhythm:

   Occur at frequencies of 14-30 Hz, they are recorded mainly from the parietal and frontal regions during specific activation of these parts of the brain, it is mainly seen during period of mental activity as well as during drowsiness, also, beta wave is activated by administration of certain medications like benzodiazepines (Ganong *et al*., 2019).

3.Theta rhythm:

Theta activity refers to activity between 4 and 7Hz, presence of theta wave is generally considered abnormal in the adult EEG during wakefulness (head injuries and brain lesions), however, the appearance of theta waves is one of the hallmarks of the onset of drowsiness, although some intermittent low-voltage theta activity is seen over the frontal–central regions in healthy people while resting and awake, under a circumstance in which the subject is performing some moderately difficult mental task, such as spelling or mathematics, one can occasionally see a well-developed theta rhythm in the frontal midline region (Blum & Rutkove, 2007).

4.Delta rhythm:

Delta wave is the frequency range below 3.5 Hz, it tends to be highest in amplitude and the slowest waves, it is seen normally in adults in sleep (deep dreamless sleep), if seen in awake adults result of a lesion or tumor may indicate damage from a stroke and it is the normal brain activity in infants, it is usually most prominent frontally in adults and posteriorly in children (Medithe & Nelakuditi, 2016).

2.2.2 Epileptiform discharges:

Fast changing abnormal electrical activities that occur during ictal and inter-ictal periods make the use of EEG ideal for diagnosis of epilepsy. These types of electrical activity are analyzed in order to predict a seizure, detect the seizure onset location, or aid the clinical diagnosis. Epileptiform discharges are divided into two types:

-Ictal discharges: these abnormal activities represent the electrical counterpart of clinical seizure and if recorded during EEG, it provides a very valuable information about seizure and epilepsy diagnosis and classification.

Interictal discharges (IEDs): they are also abnormal electrical activity but are recorded during fit free times. Usually, IEDs do not result in any clinical manifestation and are not considered as part of seizure activity. IED also provides useful information about seizure and epilepsy diagnosis and classification (Antoniades *et al.*, 2017).

The recognition of IED in EEG is an important part in diagnosis of epileptic patients, assessing spatial correlation between IEDs and seizure types in individual patients is necessary to establish the diagnosis of specific epilepsy types and syndromes (Fürbass *et al.*, 2021). It is

considered a diagnostic hallmark of epilepsy and arise from hyper synchronization of epileptogenic tissue in between seizures (Westin *et al*., 2022).

Interictal discharges have various appearances depending on the type of epilepsy and related cerebral pathology. There are multiple types of IEDs, like spike, spike wave, paroxysmal fast activity, periodic lateralized epileptiform discharges(Tatum *et al*.,2018).

Spikes are the most frequently seen IED. It has certain features that define it like:

- high-amplitude, abnormal sharp contour that stands alone from background activity.
- usually having negative polarity (upward deflection),
- short duration waveforms with morphological characteristics of a spike lasting 20 to 70 microsecond, while sharp wave with a duration of 70 to 200 microsecond.
- Should have a discernable electrical field(Scheuer *et al*., 2017).

Spike wave complex is seen when spikes followed by slow wave lasting 200 to 500 microsecond and it is more easily detected than spikes (Fisher *et al*., 2017).

Paroxysmal fast activity is another type of IEDs, it consists of rapidly repeating spikes at rate between 10-30 Hz and may continue for 3 or more seconds(Sagi *et al*., 2017).

Another type of IED is periodic lateralized epileptiform discharges which represent hemispheric or generalized epileptic activity (spikes) that repeat at characteristic rate at relative constant periods. It is considered by some authors as ictal discharge specially when associated with clinical even subtle seizure activity(Sen-Gupta *et al*., 2011).

IEDs may have distinctive recurrence rate that is characteristic but not pathognomonic of certain epilepsy syndrome, like 3 Hz spike wave activity is seen characteristically in childhood absence epilepsy(Kane *et al*., 2017).

2.3. Video electroencephalography (video EEG):

Video electroencephalography (EEG) is a simultaneous recording of EEG and video of clinical behavior over extended periods of time in a specifically equipped room, to evaluate patients with paroxysmal disturbances of cerebral function (Pressler *et al*., 2017), It is consider continuous recording of the EEG signal for at least 1 hour, and recording is based on specific needs highlighted in the EEG request provided by the physician, which is coupled with video monitoring for record event that may occur during recording, video EEG can range from 1 hour to 24 hours and can possibly be prolonged for several days or weeks, in order to establish a proper diagnosis and localization of epileptic focus which is essential prior to epilepsy surgery (Michel *et al*., 2015). Video recordings, synchronized with EEG, contain clinically relevant semiological features that occur during seizures and in the postictal period, many of these features can only be captured during epilepsy monitoring by video EEG (Neufeld *et al*., 2016), so the video EEG represents a gold standard for the diagnosis, classification and localization of epileptic seizures. While ordinary EEG which is considered as outpatient procedure in which EEG is recorded for about 30 minutes without simultaneous video recording has sensitivity for epilepsy diagnosis between 30-45%, video EEG has resulted in establishing a definitive diagnosis in 76%-88% of patients and changing in diagnosis or treatment in up to 79% of patients (Liu *et al*., 2018), video-EEG is usually performed in a hospital setting, at video EEG unit, the setting in the

controlled environment of the hospital enables staff to monitor camera position, equipment operation, and EEG recording (Sirven *et al* ., 2011).

In patients with well-known epilepsy, the sensitivity of the EEG to detect epileptiform discharge increases with longer recording time or with repeated studies, the detection rate of these discharges increased from 44% within four hours of recording to 85% and 95% after 24 and 48 h of recording respectively(Haddad *et al*., 2021), usually video EEG monitoring over 1–5 days showed a diagnostic yield about 73% with characteristic events captured during monitoring (Lim *et al*., 2020), and helped clarify the diagnosis in 93.2% of patients and led to a significant reduction in antiepileptic drug therapy in 30% of patients (Kasab *et al*., 2016).

One of the important benefits of video EEG is its clinical and economic implications in patients with pseudo-seizure, approximately 30% of those people, are misdiagnosed with epilepsy, and misdiagnosis results in inappropriate management which may lead to harmful consequences such as iatrogenic harm from side effects of anti-seizure medications, worse quality of life, excessive driving restrictions, and unemployment (Adenan *et al*., 2022).

Even though video EEG is generally considered to be a safe procedure the seizure induction methods can demonstrate a potential warning to patient's safety, and may result in serious adverse events, which can include seizure clusters and status epilepticus, postictal psychosis, falls and physical injuries (Dobesberger *et al*., 2016).

Additionally, suggestive seizure provocative procedure during video-EEG recording can be utilized, and there is no consensus on how

many days of video EEG should be recorded to allow for a spontaneous seizure to occur (Popkirov *et al*., 2017), the average length of stay in an epilepsy monitoring unit has been reported as 3-4 days for adults, with shorter durations of 1.2—1.5 days reported for children and the duration has been longer for epileptic patients undergoing a pre-surgical workup (mean 3.5 days) versus psychogenic non-epileptic seizures patients admitted for spell classification (2.4 or less days) (Moseley *et al*., 2015).

2.3.1 provocative method that is used with video electroencephalography:

Several provocation methods are used with video EEG to increase the chance of diagnosis, such as hyperventilation, photic stimulation, sleep deprivation, fatigue, drug withdrawal (Van Griethuysen *et al*., 2018).

1. Withdrawing anti-epileptic drugs(AED): AED tapering to precipitate habitual seizures is the most common technique used for increasing the yield of video EEG evaluation, AED withdrawal is safe overall, with the risk for major complications generally under 1%, it is generally accepted that relatively rapid AED withdrawal leads to a higher chance of recording the patient's seizures (Shih *et al*., 2017).
2. Sleep deprivation can induce seizures in patients with epilepsy and it might even provoke seizures in 3-5% of patients without epilepsy, concluding that it would be practical to limit sleep deprivation to patients in whom epilepsy is clinically suspected but who have normal or inconclusive standard EEG (Meritam *et al*., 2018), there is a reciprocal interaction between sleep and epilepsy, while seizures tend to occur during sleep in some epileptic syndromes, epilepsy may disrupt

the organization of sleep, sleep activation of interictal epileptiform discharges may be found and provide lateralizing information about the epileptogenic zone especially in patients with temporal lope epilepsy (Scarlatelli-lima *et al*., 2016).

3. Hyperventilation is one of the most important provocation methods during video EEG recording, hyperventilation can precipitate EEG abnormalities and seizures especially absences seizure (3 spike wave activity), thus increasing the diagnostic yield of EEG(Craciun *et al*., 2015).
4. Intermittent photic stimulation considers one of the most common provocation methods during video EEG recording, used to increase the diagnostic yield of EEG in patients with epilepsy, Photosensitivity is most frequently associated with generalized epilepsy although it is also found in healthy population (Meritam Larsen *et al*., 2021).
5. Other non-specific trigger factors: such as stress, fatigue, fever or illness that had association with temporal lobe epilepsy and idiopathic generalized epilepsy (Lunardi *et al*., 2011), also other trigger for epilepsy as seizures are triggered by contact to hot water, eating , reading ,performance special task and thinking (Striano *et al*., 2012).

2.3.2. Other type of electroencephalographic recording

Ambulatory EEG performed at home for 1 to 5 days, with or without video, and the sensitivity about 3% an ambulatory EEG so is considered lower in comparison with video EEG(Magaudda *et al*., 2016), ambulatory recording is considered cheaper and allows patients and their caregiver to go about their lives relatively normally(Goodwin *et al*., 2014), however inpatient video EEG prefer upon ambulatory, mainly because of

ambulatory EEG may be assumed less likely to capture patient events on video because it is more challenging to ensure that patient remains within video-camera field, and there is concern that EEG-tracings may be more prone to difficult to correct artifact in the ambulatory EEG (Syed *et al*., 2019).

Difference between routine and ambulatory and video EEG in **Table** (2-3).

Table (2-3): Difference between routine and ambulatory and video EEG (Sirven *et al*., 2011).

Study Type	Typical Duration	Probability of Capturing Event	EEG Quality	Video Quality
Routine EEG	20–30 minutes	Low	High	High
Ambulatory EEG	24–96 hours	Medium	Low	Low
Long term (EMU)	Days to weeks	High	High	High
Long term (bedside)	Days to weeks	High	Medium to high	Low
Long term (ICU)	Days to weeks	High	Medium	Medium to high

EEG = electroencephalogram
EMU = epilepsy monitoring unit
ICU = intensive care unit

2.3.3 Disadvantage of video electroencephalography:

1. Video EEG is considered expensive, and takes the patient out of their natural environment with increase stress to patient (Brunnhuber *et al*., 2014), and in spite of it expensive but an incorrect diagnosis can lead to unnecessary costs and inappropriate treatment (Cox *et al*., 2017).
2. An admission to the hospital may be difficult or not feasible due to home or family obligations, distance, time off work and the

availability in epilepsy monitoring units is sometimes limited, and the wait time is often significant (Benbadis, 2015), also it requires sophisticated technical equipment and a large staff of specially trained staffs(Centre & Alle, 2009).

2.3.4 Indications for Video- electroencephalographic Monitoring:

1.Differential diagnosis of paroxysmal events including epileptic seizures and organic non epileptic seizures, and psychogenic non epileptic seizures, and pre surgical evaluation in patients with medically refractory epilepsy(Baumgartner *et al* ., 2019).

2. classification and characterization of seizure types and epilepsy syndromes with quantification of seizures as well as quantification of interictal and ictal epileptiform discharges (Sirven *et al*., 2011).

3. Quantification of the number or frequency of seizures and interictal discharges and their relationship to naturally occurring events or cycles or in response (ictal and interictal) to a therapeutic intervention or modification (e.g., drug alteration) (Sirven *et al*., 2011).

4. When the management of epileptic seizures is not satisfactory in treated epilepsy, it is recommended to performed, to look for interictal spikes to potentially reassess the syndromic classification, and indicated when surgical treatment is being considered in partial drug-resistant epilepsy(Michel *et al*., 2015).

5.Video EEG is an important diagnostic tool for planning epilepsy surgery(Wang *et al*., 2017), pre-surgical evaluation of patients with medication refractory epilepsy cost effectiveness of video EEG for seizure characterization and pre-surgical evaluation(Kasab *et al*., 2016).

2.4 Neuropsychological activation protocol (NPA)

paroxysmal discharges from cortical activity induced by NPA had been described by Okuma *et al*, In 1980, NPA comprised from reading silently and aloud, speaking, mental and written calculation, writing and spatial construction during EEG recording as in figure (2-4) (Wolf, 2014), this protocol, which tests for various mental activities, has been carried out as part of routine EEG examination for patients with epilepsy (Matsuoka *et al*., 2000), neuropsychological methods of EEG activation have been used by groups from Japan (Matsuoka *et al*., 2000), Germany (Mayer *et al*., 2006), Italy (Chifari *et al.*, 2004), and Greece (Karachristianou *et al.*, 2004), as supporting method to identify specific seizure patterns in various epileptic syndromes (Guaranha *et al*., 2009), Matsuoka and associates suggested that psychomotor tasks precipitate interictal EEG discharges in some patients with epilepsy especially juvenile myoclonic epilepsy, while having an inhibitory effect in others, the mediation of such an effect has been suggested to be due to the 'cognitive demand' required for some tasks, where subclinical interictal discharges may cause ''transient cognitive impairment" (Iqbal *et al*., 2009).

Neuropsychological activation protocol are non-specific triggers that activate particular areas in cortex, NPA action by precipitation of epileptic discharges or seizures by cognition-guided tasks often involving vasomotor coordination and decision-making, seizures induced by calculation, board

games, and spatial tasks, calculations (Abarrategui *et al*., 2020), provocative rates of neuropsychological protocol vary widely from 7.9% to 84% due to the methodological differences, and neuropsychological activation required a long amount of time range from 35 minutes to 6 hours (Buluş *et al*., 2022).

Detailed neuropsychological EEG activation protocol.

(1) Writing
1. Spontaneous writing
2. Dictation
3. Copying
4. Spontaneous writing blindfolded
5. Dictation blindfolded
6. Dictation by food

Each was examined for Japanese letters (Hiragana, Katakana, Kanji), Roman letters and English letters

(2) Speaking
1. Spontaneous speaking
2. Reading aloud
3. Repeating

Each was examined in Japanese and English

(3) Other verbal activation
1. Reading silently
2. Visualizing letters
3. Making sentences in the mind

(4) Calculation
1. Calculation with hands
2. Mental calculation
3. Calculation using an abacus
4. Calculation using an electric calculator

Each was examined for subtraction, addition, multiplication and division

5. Uchida-Kraepelins psychodiagnostic test

(5) Constructional praxis
1. Spontaneous drawing
2. Sketching maps
3. Copying figures
4. Matchstick pattern reproduction
5. Block design test (WAIS)
6. Making plastic models

(6) Other tests
1. Finger tapping
2. Fine movement of the finger (tremolo)
3. Using a screw-driver
4. Bourdon cancelation test
5. Undoing puzzle rings
6. Hand, eye and ear tests (H Head)
7. Finger gnosia tests
8. Dressing
9. Color classification
10. Humming
11. Singing

Figure (2-4):Details of neuropsychological activation protocol(Wolf, 2014).

Patients who were sensitive to neuropsychological activation have worse long-term prognosis (De Marchi *et al*., 2017), also neuropsychological assessment had important role in the pre-surgical evaluation of epilepsy surgery to identify epilepsy- related cognitive impairment and their etiologic attribution to lesions (Brissart *et al*., 2019), the neuropsychological assessment provides a baseline against which changes in postoperative function can be identified, expectations of postoperative change that can be managed, and the pre-surgical assessment contributes to seizure lateralization, localization, and characterization, and provides evidence-based predictions of cognitive risk associated with the proposed surgery, including screening for amnesic risk(Baxendale *et al*., 2019).

Language activities (such as speaking and reading) and counting can trigger epileptiform EEG discharges and induce myoclonia in up to 30% of patients with juvenile myoclonic epilepsy and praxis, in which seizures are precipitated by complex tasks of vasomotor coordination and decision making (such as writing, drawing, and playing or computer games), in about 20% of patients with juvenile myoclonic epilepsy (Koepp *et al*., 2015).

Reading epilepsy is a distinct type of epilepsy provoked by NPA which all or almost all seizures are precipitated by reading, associated with focal, regional, or generalized discharges on EEG or may not be associated with EEG changes (Osei-Lah *et al*., 2010), this rare syndrome characterized by combined generalized and focal epilepsy syndrome, reflex myoclonic seizures affecting orofacial muscles triggered by reading, if reading continues, and these may worsen, and a generalized tonic–clonic seizure

may occur. Seizures are elicited mainly by reading, but also by other tasks related to language (Riney *et al*., 2022).

CHAPTER THREE

MATERIAL AND METHOD

Chapter 3

Material and method

3.1. Materials

3.1.1. Study protocol

This is a cross-sectional study conducted in neurology ward/ video EEG room in Al-mam Al-Sadiq Teaching Hospital in Al-Hillah city, through the period from September 2022 till April 2023.

The study included 47 patients with age distribution between 12 to 52 years and (25 males and 22 females). Patients are recruited from video EEG room in neurology ward after being diagnosed to have epilepsy by experienced neurologist. In addition to the diagnosis, type of epilepsy is stated also in the referral form. The diagnosis of epilepsy by the neurologist depends on clinical history including detailed history of the ictal event by the patient, his family and caregivers supported by analysis of video recording of the ictal event, neurological examination, imaging studies if needed and finally by ordinary EEG examination done at the hospital for 20-30 minutes. The diagnosis and classification were based on the latest reports of International League Against Epilepsy (ILAE).

3.1.2. Inclusion criteria:

Patients with epilepsy diagnosis aging more than 12 years were included in the study.

3.1.3. Exclusion criteria

1-Patients with diseases known to cause EEG abnormalities like migraine and degenerative disease of brain.

2-Pateints with brain surgery or head trauma.

3.1.4 Sample size

The study's sample size will be Calculated according to the following formula adopted for sample size calculation in cross sectional studies(Wayne W. Daniel, 2018).

N=Z2P(1-P)/d2

Where:

N:sample size.

Z: statistic corresponding to level of confidence which equals to 1.96 as the level of confidence is 95%.

P: expected prevalence of epilepsy syndrome.

d: precision which equals to 5% as the prevalence of disease is between 10-90%.

The prevalence of epilepsy in Iraq is 21 per 1000 (Hussain & Lafta .,2019).

According to formula sample size=32.

In this study takes all patients that attend to neurology ward, that equal to 72 patients including newly diagnosed epilepsy were examined for possible inclusion in the research. However, significant number of patients (25) were excluded due to the fact that they did not meet the diagnosis of epilepsy after video EEG.

3.1.5.Ethical Approval

The committee on publishing ethics in Babylon University/College of Medicine gave its approval to this work. Which certified it at number 675 in July 21,2022. And verbal consent of participation was obtained from the patient.

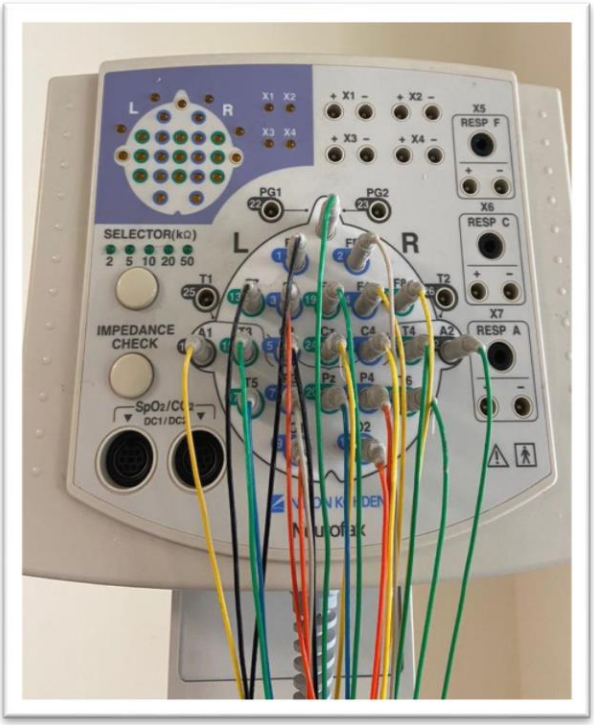
3.1.6 Instruments used in this study

Table (3-1): show the instruments used in this study.

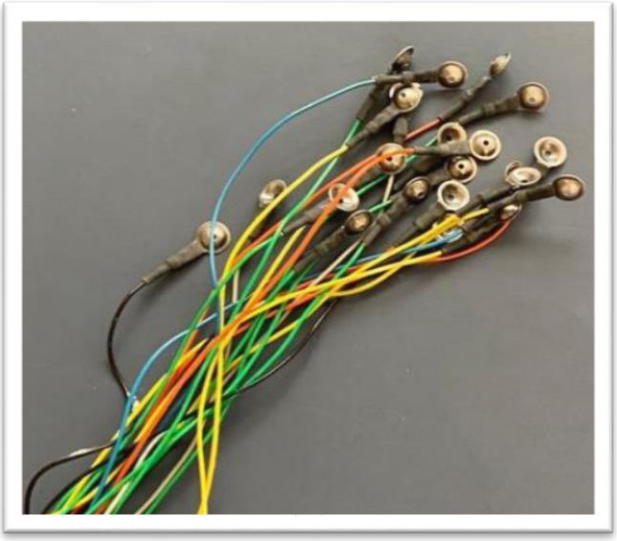
Instrument	Supplying company	Country	Years
22-channel EEG machine	Nihon kohden	Japan	**2014**
EEG paste (Elefix)	Nihon Kohden	Japan	
22 Electrodes system	Nihon Kohden	Japan	**2014**
Skin preparation gel	Nihon Kohden	Japan	
Video-EEG software (KT88-1016)	Nihon kohden	Japan	**2014**

-Instruments used show in **figure** (3-1).

A. EEG machine



B. head box



C.22 Electrodes system

Figure (3-1; A-B-C): Instruments used in this study.

3.2 Methods

All subjects enrolled in the study undergo the following examinations:

1- History.
2- Video electroencephalographic recording with neuropsychological protocol.

3.2.1 History

All of the subjects had their histories taken in detail, including demographic and clinical data which were collected based on specially designed questionnaire.

3.2.2 video electroencephalographic examination

Patients arranged for video EEG are asked to have many preparations, including head washing, hair shaving for men and shortening for women, sleep deprivation by asking the patient to awaken 4 hours earlier than usual wakefulness time, and delaying the morning dose of antiepileptic drug to be after the video EEG examination if possible. Valium ampules are prepared together with the O2 in case a seizure does occur.

Before proceeding to the EEG examination, the patient is reassured and informed about the study procedure and its different parts and activation techniques. Scrubbing of scalp areas that will be used for electrode placement using scrubbing jell and a wooden stick coated with cotton to decrease electrode impedance below 5000 ohms. Electrodes are fixed at their sites on the scalp using by EEG paste.

The electrode placement was according to the 10-20 system (Blum & Rutkove, 2007), which is the main and most widely used electrode placement protocol. The patients were instructed to stay calm, relax all their muscles, especially

the cranial muscles, and minimize blinking and eye movement, not moving their body during recording. Where the patient stays in a supine position during recording and under the observation of attendants, and recording continues for 2 to 6 hours.

3.2.3 Recording principles

According to a specified placement scheme known as the International 10-20 system, EEG recording electrodes are adhered to the scalp in an organized manner.

The electrodes are compared after being inserted into a headbox with a differential amplifier. The differential amplifier amplifies the voltage difference at the two input sites and has two inputs (G1 and G2). In the case of an analog-based EEG unit, the output is then charted onto a graph to show the voltage differential against time. When using a computer-based system, the inputs are digitized, and the amplifier registers the voltage differences and stores them as a digital signal for display on a cathode ray tube (Blum & Rutkove, 2007).

After that, the obtained data are displayed in a montage. We use two montages to analyze the patient's EEG record, longitudinal bipolar and referential montage using ear as a reference.

10 –20 electrode placement system was used to apply the electrodes to their correct sites, the scalp is subdivided into proportionate intervals from major skull structures "nasion, preauricular points, inion" to maintain appropriate encasement of all parts of the brain; the notation 10-20 indicates proportionate spacing in percentages between the ears and the nose, where electrode locations are selected, as illustrated in **figure** (3-2) (Sazgar *et al*., 2019).

These electrodes are labeled by letters corresponding to nearby brain areas: "F (frontal), C (central), T (temporal), P (parietal), and O (occipital)", indicating the

lobes of the brain; the midline region is referred to by a label with 'z'. On the left side of the head; the letters are represented by odd numbers, whereas on the right they are represented by even numbers; and an additional sensor is used to record special applications such as heart rate and respiration (Kumar *et al*., 2012).

Then EEG is stored in a computer.

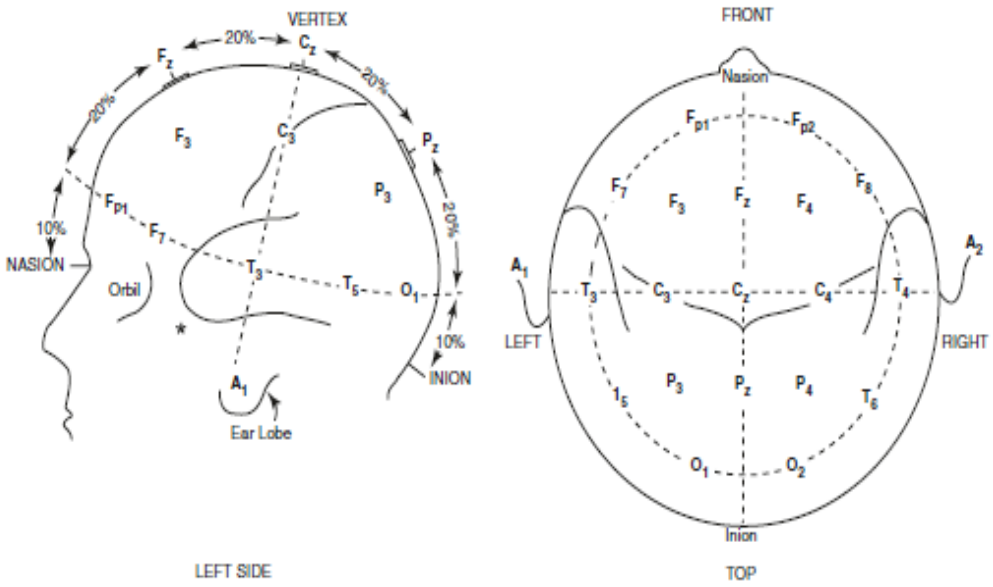


figure (3-2): The international 10–20 system is used for electrode placement (Sazgar *et al*., 2019).

3.2.4 Electroencephalographic analysis

The EEG technical details are, high cut filter 70 Hz, low cut filter 1 Hz, time constant 0.3, impedance <5000 ohms. The sensitivity of EEG is kept between 7-15 uv/second. The EEG record was displayed as waveforms of varying morphologies

and frequencies, and analysis for presence of interictal discharge, frequency and type of ictal EEG change that observe together with video record.

Analysis of EEG records along with video recording are done by experienced clinical neurophysiologist who was blind of the patient's history or initial diagnosis proposed by the neurologist. The data obtained from video EEG are then incorporated along with the patient's history and other clinical and imaging data and discussed with the neurologist to have final diagnosis and classification of epilepsy syndrome. In bipolar montages, "phase reversal," a deflection of the two channels within a chain pointing in opposing directions, is typically used to localize normal or abnormal brain waves. In a "referential montage," in general, the electrode with the largest upward deflection represents the maximal negative activity. After ensuring that the EEG is free of artifact, impedance is below 5 Kohms, stable baseline and all electrodes are well conducting we will start EEG recording. The EEG record consists of different stages or phases as shown below:

3.2.4.1 Recording non-activation stages

a- eye closure phase

This is the first part of EEG record, during which patient is asked to close eyes voluntarily with minimal contraction of extraocular muscles and without blinking or moving head while he is lying down on the bed, recording continued for 15 minutes.

b- eye open phase

It represents the second stage of the EEG record by asking patient to open their eyes with a fixed gaze to minimize artifacts, and the recording continues for 15 minutes. With monitoring video recording for any attack of ictal state that might occur through recording.

3.2.4.2 Recording activation stages

a- Hyperventilation stage

We instruct the patient to hyperventilate by taking deep breaths in and out at a rate faster than his usual respiratory rate (we told him to breathe deeply as if he were running or climbing high stairs). This phase will continue for 3 to 5 minutes and be repeated 2-3 times with periods of 2 minutes apart. During hyperventilation, close monitoring of the patient's condition and EEG is needed due to the potential development of an ictal event.

b- Intermittent photic stimulation(IPS)

Start this stage by asking the patient to fix their gaze on the photic source instrument that constantly flashes toward patient's face at an incremental rate (flashes 1, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 33, 50, and recovered) without blinking or moving their eye. Provide photic stimulation for 3 minutes with repeated intermittent photic stimulation 2 or 3 times throughout the recording.

c- Neuropsychological activation protocols

The neuropsychological activation protocol (NPA) was usually done after photic stimulation. It took 30-45 minutes and consisted of achieving multiple tasks or answering certain questions by the patient.

The details of neuropsychological activation protocols are shown in **table** (3-2).

There are some difficulties in performing neuropsychological activation for some patients, including difficulties in reading, writing, and mathematical calculation because of the level of education of some patients (illiterate and primary school), in

addition to movements of hands or heads of patients during the procedure that lead to some artifacts through EEG recording.

Table (3-2): neuropsychological activation stages.

"Reading an Arabic text (patients read the same sentences aloud that they had read silently); this was a medical text describing seizures

10 minutes silently

10 minutes aloud

Reading an English text if possible

10 minutes silently

10 minutes aloud

Speaking aloud for 5 minutes (patients described their seizures, their lives, and the impact of epilepsy)

Writing for 5 minutes (patients were asked to write about their seizures)

Mental calculation: subjects responded aloud with answers to four arithmetic problems (18 − 7, 23 + 46, 11 × 11, 125 ÷ 5); when calculation was difficult, an easier problem was presented

Written calculation: patients responded in writing to one arithmetic problem (15 × 67 × 23 × 48)

Drawing: patients were instructed to draw a family, a house, and a clock showing quarter to four.

Spatial construction:

Patients performed a sequence of tasks, for 10 minutes each: Rubik's cube arranging".

3.2.4.3. Sleep EEG

After completing neuropsychological activation, the patient is asked to attempt sleep, which was aided by dimming the room and stopping any talking or movement in the room. During this EEG recording, it is continuous, which enables us to record different sleep stages and any EEG changes during each.

3.2.4.3 Termination of video EEG recording

Video EEG recording was terminated if one of the following occurs

1. development ictal event.
2. patient's wish, in many cases patient refuse to continue recording and asks terminate it.
3. development of interictal discharges that is characteristic of specific epilepsy syndrome, after 2 hours of recording.

3.2.5 Measurements EEG change through recording of non-activation and activation stages on IEDs

All EEG recordings were evaluated for the presence or absence of epileptiform discharges with the effect of non-activation and activation stages, hyperventilation, and IPS, and neuropsychological activations on EEG change, quantity frequency, and type of IEDs or ictal change. This helps in the classification of epilepsy syndrome as in figure (3-3) and (3-4) and (3-5).

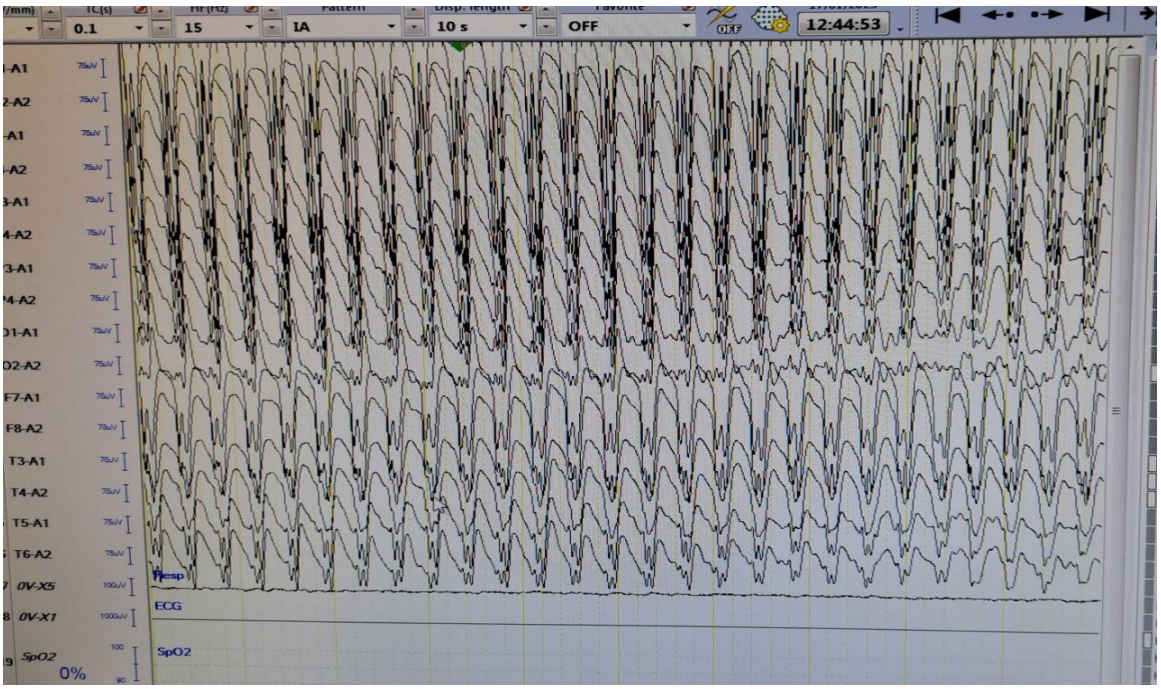


Figure (3-3): 3-spike wave during hyperventilation stage.

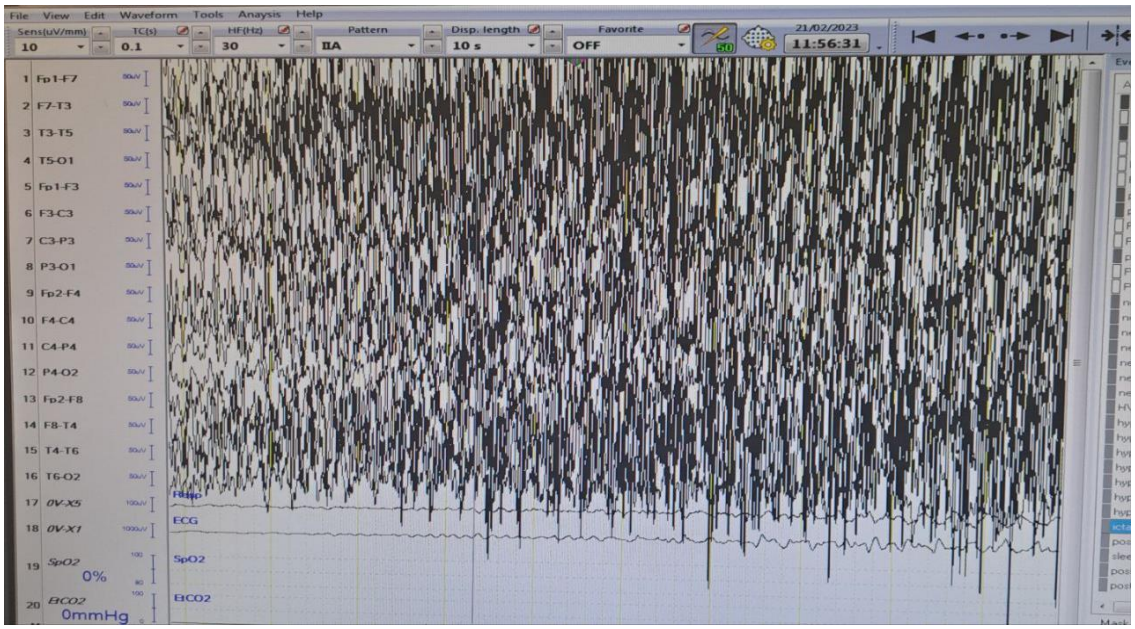


Figure (3-4): generalized spike wave activity with myogenic artifact in patient had got generalized tonic clonic seizure during hyperventilation.

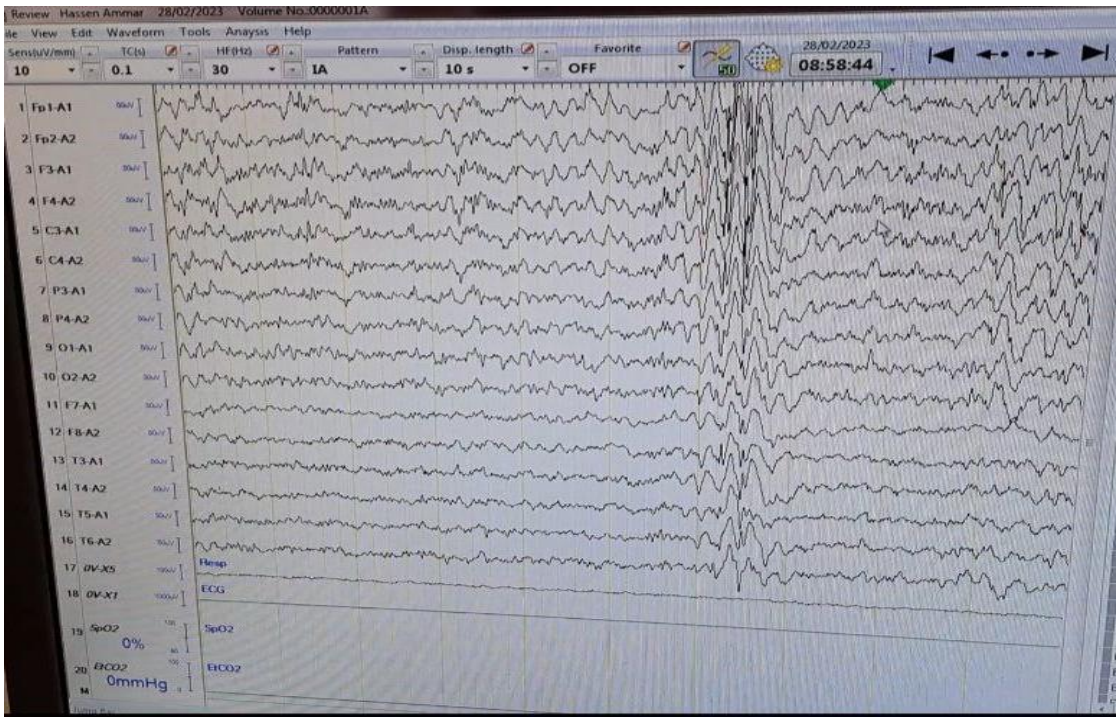


Figure (3-5): Generalized epileptiform discharge in patient with epilepsy that appear with NPA.

3.3. Statistical analysis

All statistical analyses were performed using SPSS software (version 23).

P value < 0.05 was considered significant(Wayne W. Daniel, 2018).

CHAPTER FOUR

RESULTS

Chapter 4

Results

The results of this study are shown and expressed as EEG parameters (epileptiform discharge) in different seizure types with neuropsychological activation protocol in classification seizures.

4.1 Demographic data

Our sample shows a slight male predominance (male/ female ratio= 1.1:1). The mean of their ages was 24.83 ± 10.033. A minority of patients (9 patients, 19%) had a positive family history of a similar condition. The education level of the majority of patients is primary school. Most of them live in urban area. Most of them live in urban area. On the other hand, a majority of participants were not employed The demographic data collected is shown in **table** (4-1).

Table (4-1): The demographic data of study participants.

Variable	Finding
Male: female ratio	1.1:1
Positive family history	9 (19 %)
Age (years)	24.83 ± 10.033
Education level; primary school	44.68%
Address of patients; urban area	53.19%
Not employed	57.44%

Results are shown as numbers (percentage), mean and standard deviation.

4.2. Video electroencephalographic (video EEG) findings

The findings of video EEG recording are shown in the following sections and tables

4.2.1. Types and frequency of interictal discharges(IEDs)

The most frequent type of IEDs recorded during video EEG is spike activity, followed by spike-waves, other IEDs recorded during video EEG are shown in **figure** (4-1).

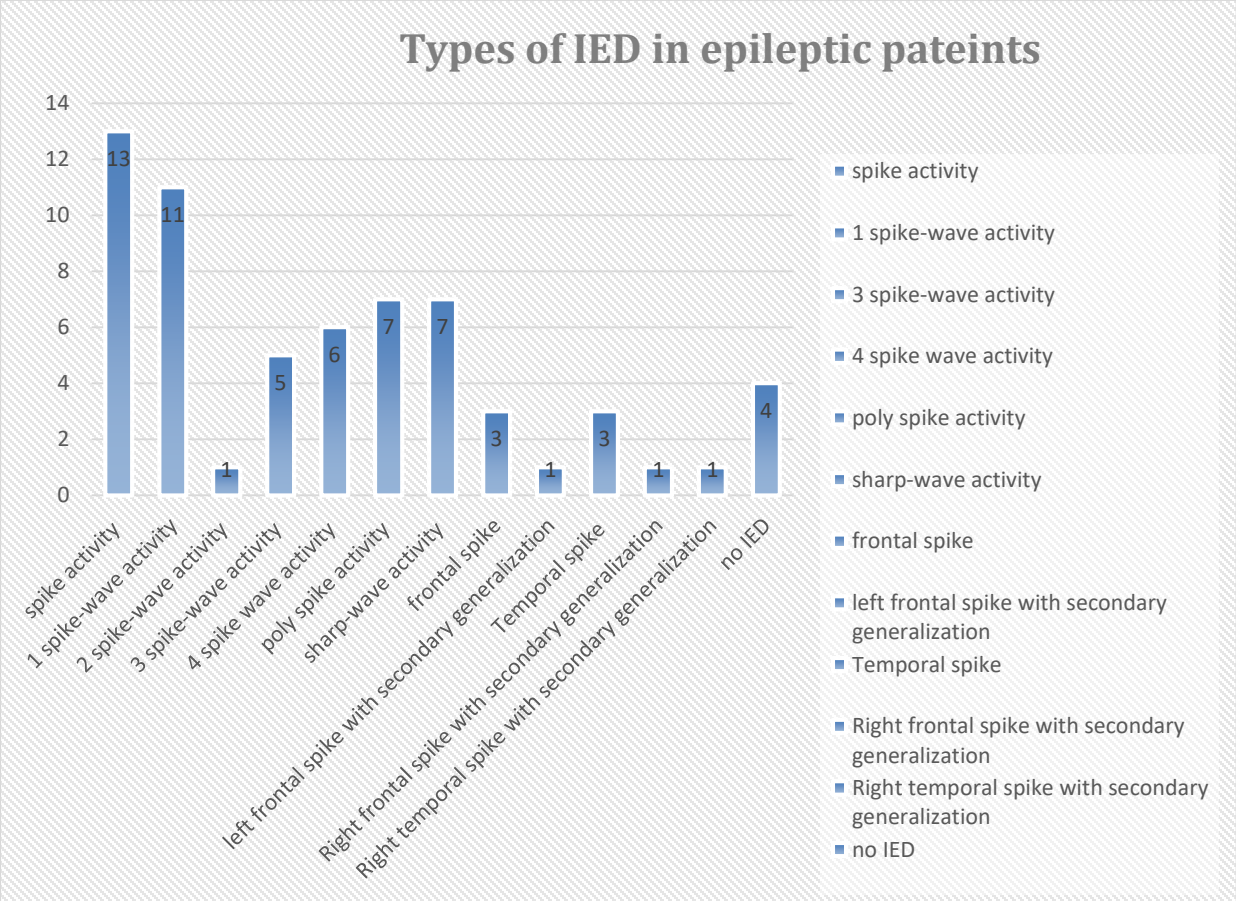


Figure (4-1): Types and frequency of interictal discharges.

4.2.2 Types of interictal discharges in each seizure type and epilepsy syndrome

The results of this study showed that most patients developed IEDs throughout video EEG recording (91.48%). The types of IEDs differ according to the type of epileptic disorder; these results are shown in table (4-2).

Table (4-2): Types of IEDs in each seizure type and epilepsy syndrome.

Seizure Type	No. patient	Type of epileptiform discharge	Number and percent of patient in each type IEDs
GTC	21	Spike wave activity	9 (19.14%)
		Spike activity	7(14.89%)
		Sharp wave activity	3(6.37%)
		No IED	2(4.25%)
JME	10	Spike wave activity with poly spike	4(8.5%)
		4-spike wave activity	4(8.5%)
		4-spike wave activity with poly spike	2(4.25%)
JAE	3	3-spike wave activity	3(6.38%)
Focal to bilateral tonic clonic	4	Right frontal spike with secondary generalization.	2(4.25%)
		Left frontal spike with secondary generalization.	1(2.12%)
		Left temporal with secondary generalization.	1(2.12%)
Temporal lobe epilepsy	3	Temporal spike	2(4.25%)
		No IED	1(2.12%)
Frontal lobe epilepsy	3	Frontal spike	3(6.38%)
CAE	2	3-spike activity	2(4.24%)
Focal seizure with impaired awareness	1	No IED	1(2.12%)

GTC: generalized tonic clonic; CAE: childhood absence epilepsy; JME: juvenile myoclonic epilepsy; JAE: juvenile absence epilepsy. Results are shown as numbers (percentage).

4.3. Classification of seizures types and epilepsy syndrome

Seizure types are classified based on the "International League Against Epilepsy"-2017 "ILAE-2017", which showed that most seizure types were generalized onset seizures and generalized tonic-clonic seizures being the most frequent of them. These results are shown in **table** (4-3).

Table (4-3): Classification of seizures and epilepsy syndrome according to ILAE-2017.

Seizure classification			Epilepsy syndrome	
Focal onset (11, 23.40%)	Impaired awareness	1(2.1%)		
	Focal to bilateral tonic clonic.	4(8.5%)		
	Focal aware seizure	6(12.8%)	Frontal lobe epilepsy	3(6.4%)
			Temporal lobe epilepsy	3(6.4%)
Generalized onset (36, 76.59%)	Motor	31(66%)		
	Generalized Tonic-clonic	21(44.7%)		
			juvenile myoclonic epilepsy	10(21.3%)
	Non-motor(absence)	5(10.7%)	Childhood absence epilepsy	2(4.3%)
			juvenile absence epilepsy	3(6.4%)

Results are shown as numbers (percentage).

4.4. Classification of seizures before and after video EEG

The study shows that a large number of patients (27 patients, 57%) with seizures have fallen into a new category in the ILAE classification of seizure type or epileptic syndromes after careful assessment for video EEG recording. This finding is shown in **table** (4-4).

Table (4-4): Classification of seizure before and after video EEG monitoring.

Classification before	Classification after	Number of patients
Generalized tonic-clonic	juvenile myoclonic epilepsy	9(19.14%)
Focal seizure	Frontal lobe epilepsy	3(6.38%)
Benign Rolandic epilepsy	juvenile myoclonic epilepsy	1(2.1%)
Absence seizure	Childhood absence epilepsy	1(2.1%)
Generalized tonic-clonic	Focal to bilateral tonic-clonic	4(8.5%)
Complex partial seizure	Generalized tonic-clonic	1(2.1%)
Generalized tonic-clonic	Childhood absence epilepsy	1(2.1%)
Focal seizures	Temporal lobe epilepsy	2(4.2%)
Complex partial seizure	Temporal lobe epilepsy	1(2.1%)
Absence seizures	juvenile absence epilepsy	3(6.38%)
Complex partial seizure	Focal seizure with Impaired awareness	1(2.1%)
Total		27(57%)

Results are shown as numbers (percentage).

4.5. Ictal attack induced through Video-EEG recording

Through activation and non-activation states of video-EEG monitoring. The majority (41) of patients did not develop an ictal state, while 6 patients developed ictal phenomena like staring, generalized tonic-clonic seizures and other. These findings are shown in **table** (4-5).

Table (4-5): Ictal state induced through video EEG recording.

Number of patients	Ictal state	Type	Activation state and non-activation state
1(2.1%)	Yes	Staring	Neuropsychological activation/ Rubik's cube
1(2.1%)	Yes	Staring	Eye open
1(2.1%)	Yes	GTC	Hyperventilation
1(2.1%)	Yes	Left leg jerky movement	Eye open and hyperventilation
1(2.1%)	Yes	Staring	Hyperventilation
1(2.1%)	Yes	Staring	Hyperventilation and NPA reading and mathematics.

GTC=generalized tonic clonic; NPA= Neuropsychological activation. Results are shown as numbers (percentage).

4.6. The epileptiform discharge during non-activation and activation and sleep stages of video EEG recording

The IEDs detected in different stages of EEG recording, whether non-activation stages (eye closed, eye opened) or activation stages (hyperventilation, photic stimulation, neuropsychological activation (NPA) stages), and sleep, are shown in **table** (4-6). The table clearly states that most IEDs are induced by activation procedures, with hyperventilation being the most important activation procedure.

Table (4-6): number of epileptiform discharges in non-activation and activation stages of video EEG recording.

Non-activation stages				Activation stage		Sleep Stage
Number of patients						
epileptiform discharge	Eye closed	Eye opened	Hyperventilation	Photic	NPA	
Absent	19(40.42 %)	22(46.80%)	5(10.63%)	34(72.34%)	13(27.7%)	4(8.5%)
Present	28(59.57 %)	25(53.19%)	42(89.36%)	13(27.65%)	34(72.34%)	43(91.48%)
Total percent	47(100 %)	47(100 %)	47(100%)	47(100 %)	47(100 %)	47(100 %)

Results are shown as numbers (percentage). NPA= neuropsychological activation.

4.7. Relation between each recording stage according number of epileptiform discharge

When correlated between hyperventilation, photic, NPA, eye opened, eye closed according to the number of IEDs, a statistically significant correlation was found between each stage (p value <0.05 considered significant, as shown in table (4-7).

Table (4-7): Relation between each recording stage according number of epileptiform discharge.

Activation stages	Absent of IEDs	Presence of IEDs
hyperventilation	5	42
Photic	34	13
NPA	13	34
Eye opened	22	25
Eye closed	19	28
P value		<0.01

IEDs= Interictal discharges. NPA=neuropsychological activation.
Results are shown as number (percentage).
P value is considered significant if < 0.05

4.8. Effect of neuropsychological in induce IEDs in each seizure type

Interictal epileptiform discharges induced in each type of seizure throughout the neuropsychological activation protocol, according to the type of seizure, is shown in table (4-8). It clearly informs us that a significant number of patients (34) developed IEDs, patients with focal seizures appear to be more sensitive to induced IEDs by neuropsychological activation protocols, and one patient with frontal lobe epilepsy had IEDs only during the neuropsychological activation protocol stage with normal EEG in other recording stages.

Table (4-8): Effect of neuropsychological in induce IEDs in each seizure type and epilepsy syndrome.

Classification of seizure			Number of patients with epileptiform discharge in neuropsychological activation	Percent of NPA effect in each type	Percent of NPA effect of each type from total patients
Focal seizure	Impaired awareness		0	0%	(0%)
	Focal to bilateral tonic clonic.		4	100%	(8.51%)
	Aware	Temporal lobe epilepsy	2	66%	(4.25%)
		Frontal lobe epilepsy	3	100%	(6.38%)
Generalized seizure	motor	Tonic-clonic	14	66.6%	(29.78%)
		juvenile myoclonic epilepsy	7	70%	(14.89%)
	Non-motor (absence)	Childhood absence epilepsy	2	100%	(4.25%)
		juvenile absence epilepsy	2	66%	(4.25%)
Total percent					72.3%

Results are shown as numbers (percentage).

4.9. Difference between focal and generalization according neuropsychological activation

A comparison between the number of patients who developed IEDs during the neuropsychological activation protocol according to focal or generalized seizure had shown that, between the two groups, there was no statistically significant, difference as shown in **table** (4-9).

Table (4-9): Different in focal and generalized epilepsy according to effect of neuropsychological activation.

	Number of IEDs in NPA	0	1	2	3	4	5	Total
Generalized onset seizure	Number of patients	11(30.1%)	7(19.44%)	9(25%)	3(8.33%)	5(13.88%)	1(2.77%)	36
Focal onset seizure		2(18.18%)	2((18.18%)	4(36.36%)	1(9.09%)	1(9.09%)	1(9.09%)	11
	Total	13	9	13	4	6	2	47
	P value	0.874						

P value is considered significant if < 0.05. Results are shown as number (percentage).
IEDs=interictal discharges, NPA=neuropsychological activation.

4.10. Provocative effects of different tasks of neuropsychological activation protocol on epileptiform discharges

Analysis of the results informs us that mathematics (written calculation) is considered the most important protocol that induces IEDs in patients with epilepsy, followed by reading (aloud) activity, as shown in **table** (4-10).

Table (4-10): Effects of different tasks of neuropsychological activation protocol on epileptiform discharges.

neuropsychological activation protocol		Number of patients with epileptiform discharges In NPA
Reading	Silent	3(6.38%)
	Aloud	12(25.53%)
Speaking	Silent	2(4.25%)
	Aloud	2(4.25%)
Writing		1(2.1%)
Mathematics	Mental calculation	2(4.25%)
	Written calculation	14(29.78%)
Drawing		6(12.76%)
Rubik's cube		5(10.63%)
Total		47(100%)

Results are shown as numbers (percentage). NPA= neuropsychological activation.

CHAPTER FIVE

DISCUSSION

Chapter 5

Discussion

5.1. Effect of demographic data

This study included 47 patients, 25 (53.2%) were males and 22 (46.8%) were female, with a 1.1:1 male to female ratio as stated in the table (4-1).

This result indicate that the incidence of epilepsy is slightly higher in male compared to female, accordingly, it agree with many other studies which noticed such finding (Beghi *et al*., 2020);(Strzelczyk *et al*., 2023).

This gender difference could be multifactorial, and in spite of presence of some epilepsy syndromes like idiopathic generalized epilepsies (like childhood absence epilepsy and juvenile myoclonic epilepsy), which represent 15-20% of epilepsy, are more common in females, epilepsy is still diagnosed more frequently in males. This paradox could be due to the lower rate of female attendance at medical care due to the gender disparity seen in many countries, especially developing once(McHugh & Delanty, 2008).

This finding may be due to the increased exposure of males to conditions that increase their likelihood of developing epileptic symptoms, particularly head injuries, strokes, and infections of the central nervous system, or alcohol-related epilepsies, which are also significantly more common in men(Morrell, 2004).

The minority of patients with positive family history, as shown in table (4-1), however, Chentouf and colleagues (2015), revealed most patients diagnosed with epilepsy had a positive family history, also Babtain (2013) reported that one in four epileptic patients had a positive family history of epilepsy.

This finding is explained by the fact that most of our patients deny any family history of epileptic disorders, possibly due to the social stigma proposed by most of them.

The study displays the patients living in urban area have higher incidence than those living in rural area as shown in figure (4-2), this contradicts the finding of Ghiasian and his study group (2020) who reports higher incidence in rural areas (58.4%).

This is also explained by the fact that most people living in rural areas have a lower rate of attendance at medical services due to low socioeconomic status, and most of them prefer traditional medicine and mountebanks over a scientific approach to modern clinical services.

5.2. Types epileptiform discharges and frequency during Video encephalographic (EEG) recording in each type of seizures

The percent of patients who had IEDs during EEG recording was 91.48%; however, the types and frequency of epileptiform discharges differ according to the type of seizure. The most frequent type of IED in this study is spike activity, followed by spike-wave activity, as shown in figure (4-1).

The results of current research explained in Table (4-2) show that there were 11 patients with focal seizures; one of them had a focal seizure with impaired awareness diagnosed by clinical features and seizure semiology, but his video-EEG was normal.

This finding is seen in many other studies and researches like Koc *et al.* (2019), who reveal that focal-onset epilepsy is more likely to demonstrate normal EEG without any IEDs even with trial of long-term recording and proper application of activation protocols, especially in focal seizures with preserved awareness.

Also, there are 3 patients with frontal epilepsy, and all of them had frontal localized IEDs, whereas Andrade-machado *et al*. (2021) express that the EEG of patients with frontal lobe epilepsy up to 40% does not reveal epileptiform discharges.

Also, in this study there are 3 patients with temporal lobe epilepsy (TLE), and 2 of them had predominant temporal spikes through video-EEG monitoring. This is in the same direction with Tatum *et al*.(2012), who show IEDs located in the antero-temporal over the regional temporal field is the characteristic feature of TLE.

In addition to that, studies conducted by Bercovici *et al*.(2012) and Werhahn *et al*.(2015) demonstrated that IEDs are found in 95% and 94.4% respectively, of TLE patients.

Furthermore, the study had 4 patients with focal to bilateral tonic clonic, 3 of them with frontal spikes with secondary generalization and one with temporal spikes with secondary generalization, but Andrade-machado *et al*. (2021) express that the most common type of focal epilepsy associated with secondary generalization is TLE.

Regarding generalized onset epilepsy, there were 10 participants with juvenile myoclonic epilepsy (JME). All patients had EEG changes and varied in types of epileptiform discharge (4-spike wave activity, spike wave activity, and polyspike activity); however, Dhamija *et al*. (2018) show the EEG is abnormal in 50%-85% of patients with JME.

As well, we had 2 patients with childhood absence epilepsy; all of them had IEDs in the form of 3 Hz spike wave activity. This agrees with Mariani *et al*.(2011), who show similar results and detected IEDs in all cases of childhood absence epilepsy.

Also, we had 21 patients with generalized-onset tonic-clonic seizure; the majority of them had IEDs (spike wave activity, spike activity, sharp wave activity).

This agrees with the results of Werhahn *et al*. (2015), who show similar results about IEDs being present in 92% of patients with generalized epilepsy.

In spite of Ghougassian *et al*.(2004), who illustrated IEDs during video EEG in 43% of patients with generalized tonic-clonic epilepsy.

In the same direction, Tatum *et al*. (2018) show that IEDs in patients with generalized onset epilepsy are symmetrical, synchronous, frontally predominant, generalized spike-wave, or polyspike-and-wave.

In this study, IEDs appeared in most cases due to the fact that video-EEG monitoring was performed for extended periods that permitted us to record any epileptiform discharge occurring at a particular time throughout the recording, with video recording that allows us to capture events and compare them with simultaneous EEG recordings. Also, we applied multiple properly done provocative measures such as hyperventilation and intermittent photic stimulation (IPS) multiple times throughout recording in addition to the neuropsychological activation protocol (NPA), with as much preparation of patients with sleep deprivation and drug tapering as possible.

5.3. Classification of seizures type epilepsy syndromes according ILAE_2017

ILAE-2017 classification shown in table (4-3).

In this study, generalized-onset seizures (motor, tonic-clonic) appear to be the most common type of epilepsy.

This is in contrast to the study of Rozendaal *et al*. (2016), who demonstrate that focal onset seizures -focal aware, focal impaired awareness, and focal to bilateral tonic -clonic were the most prevalent types.

This may be related to the fact that patients with generalized epilepsy are more likely to attend to medical care and seek management than those with focal onset seizures which are usually illustrated by a variety of explanations like tic, psychological cause… etc.

5.4. Classification of seizures before and after video EEG

In this study, the performance of video EEG results in ameliorating initial diagnosis of seizure type in 27 patients (57.45%), as expressed in table (4-4).

This is in agreement with results of Ghougassian *et al*. (2004), who show that 58% of the diagnosis of epileptic patients was altered as a result of the video EEG.

This finding is explained by the reality that video EEG is a powerful tool for assessing epileptic patients and is very helpful in the diagnosis and classification because it allows the investigator to properly identify the ictal event (if it happened) and compare it with time-locked EEG recording. In addition to that, it helps in better characterization and understanding of IEDs than ordinary EEG records(Tatum *et al*., 2022).

5.5. Ictal attack induced through Video-EEG recording

During video-EEG recording in this study, only six patients (12.6%) developed an ictal state at different stages of recording, as shown in table (4-5).
A group of patients (4) developed a staring attack for 8-12 seconds (one during eye opening, 2 during neuropsychological activation (one during arranging Rubik's cube, one during mathematical calculation and reading) and also during the hyperventilation stage). Another patient had generalized tonic-clonic seizure during hyperventilation, which continued for 1 minute.

This finding contradicts the study of Gelžiniene *et al*. (2015), in which, during the EEG recording, none of the patients had clinical seizures.

While other study of Baraldi *et al.* (2015) show particular seizure types, mainly drop attacks (atonic and tonic seizures), seen in 2.3% of video EEG monitoring.

Whereas Kane *et al.,* (2014) show epileptic seizures were precipitated by hyperventilation in 2.2% of patients.

As well, the study of De Marchi *et al.* (2017) shows that hyperventilation and intermittent photic stimulation increase the risk of inducing seizures, including generalized tonic-clonic seizures.

The explanation of the low rate of capturing ictal events during video EEG recording may be related to the fact that some patients were on regular treatment with reasonable control of seizures or to the fact that video EEG recording was terminated prematurely in many cases based on the patient's wishes, resulting which reduced the chance of catching ictal manifestations(B. Chen et al., 2017).

5.6. Effect of neuropsychological in induce IEDs in each seizure type

Interictal discharges induced by the neuropsychological activation protocol are shown in table (4-8). NPA induced IEDs in 72.3% of the total patients enrolled in the study. This is similar to the study of De Marchi *et al*. (2017), who expressed the cognitive tasks provoked IEDs in 84% of patients.

In contrast to Matsuoka *et al.* (2000), who found that 7.9% of all patients with various epilepsy types experienced IEDs in response to neuropsychological activities.

In this study, the most effective outcome of NPA appeared in focal to bilateral tonic-clonic and frontal lobe epilepsy, with CAE as the effect accounting for 100% of each type.

Also, the percentage of patients inducing IEDs in this study is different according to the type of epileptic disorder; in patients with JME, 70% of them developed IEDs during NPA, while in patients with temporal lobe epilepsy, generalized tonic-clonic, and JAE, the percentage is 66.6%. Other studies conducted by Matsuoka *et al.* (2000) markedly different results in different epileptic disorders, like JME (46.7%), followed by JAE (16.7%), general tonic-clonic (15.8%), and CAE (7.1%).

On the other hand, controversial results are seen regarding focal onset seizure; some authors have demonstrated that NPA may cause an inhibitory effect on focal onset seizures except temporal lobe seizures (Matsuoka *et al*., 2000) and a precipitating effect on general onset epilepsy.

Even though Miyoklonik *et al*.(2013) show that the NPA test provoked EEG discharges in 23.3% of patients.

In this study, all three patients with frontal lobe epilepsy showed frontal lobe spike and spike wave abnormalities during NPA, with one of them showing completely normal video EEG except at NPA.

Neuropsychological activation has precipitating effects on higher mental activities that can provoke generalized IEDs. NPA may be attended by myoclonic or absence seizures; seizures precipitated by a specific trigger would be a subtype of JME. This essentially reveals that JME are highly responsive to the provocative effects of NPA. Epileptic discharges that were induced in generalized epilepsy by NPA were relatively similar to those that appeared spontaneously; they consisted of diffuse and symmetric spike-wave or polyspike-wave complexes, also seizure

susceptibility to higher mental activities in generalized epilepsy syndromes suggests a pathophysiological similarity between syndromes (Matsuoka *et al*., 2000).

Also, cognitive functions can have different effects on IEDs depending on the specific neural pathways involved. The parietal cortex is an important region involved in many cognitive functions. When the parietal cortex is activated, this can lead to the propagation of neural signals to other areas of the brain, including the frontal cortex. This activation can trigger IEDs. For example, a written calculation may involve activation of the parietal cortex and frontal cortex, which can trigger IEDs in individuals with epilepsy. If the activation of the parietal cortex occurs without motor involvement, the effect on IEDs is inhibitory (Guaranha *et al*., 2009).

5.7. Provocative effects of different tasks of neuropsychological activation protocol on epileptiform discharges

In this study, use group of activation procedures for cortical activation to induce epileptiform discharge, as shown in **table** (4-10).

Mathematics (written calculation) is considered the most common technique that induces IEDs at a rate of 29.78%, followed by reading loudly at a rate of 25.53%.

In this study, both written calculation and reading loudly induced staring attacks in patients with JAE, despite the fact that de León *et al*. (2016) had found that myoclonic seizures were triggered by mental calculation.

Likewise, in this study, Rubik's cube arranging activity provoked IEDs in 10.63% of patients, and one patient (JAE) had a staring attack through this activation procedure.

Unlike the study of Guaranha *et al*.(2009), which revealed that action-programming tasks may be more effective than thinking tasks in provoking IEDs in individuals with epilepsy, action-programming tasks induced IEDs in 84.2% of patients and thinking induced IEDs in10.5% of patients only.

However, Buluş *et al*.(2022) show verbal tasks and arithmetic tasks provoked IEDs in 11.4% and 5.7% of patients, respectively; also all activated patients had generalized epilepsy, and mental calculation increased the yields of IEDs between 5.1% and 7.9%.

In contrast to the study of Gelžiniene *et al*. (2015), which revealed less than one-fifth of patients with generalized epilepsy experienced IEDs in response to neuropsychological activation tasks, all of the neuropsychological activation tasks had similar provocative effects, indicating that different types of cognitive tasks may have similar effects on IEDs in some individuals with epilepsy. However, there was a tendency for tasks that required both planning and purposeful hand movement to have more prominent provocative effects; this may be related to the activation of motor regions of the brain that can be involved in both planning and executing purposeful hand movements, while mental reading did not provoke EEG discharges. Although De Marchi *et al*.(2017) study exhibits that 39.8% of IEDs triggered by neuropsychological activation tasks related to praxis, language, and flashing lights were found to be provocative in some patients with epilepsy. Among those, the provocative effect was confirmed in 53.3% of patients during neuropsychological activation (10 patients had induction by praxis; eight by photosensitivity; four by praxis and language; one by language; and one by praxis and photosensitivity).

In this study, proven use of NPA for induction IEDs, especially uses of written calculation, reading aloud, and arranging Rubik's cube, was also associated with provocation ictal attacks (especially staring) in addition to IEDs.

Finally, the neuropsychological activation protocol had a significant role in the evaluation of patients with epilepsy since it could support the diagnosis and classification of seizures, and identify precipitating factors, helping to choose appropriate treatment and improving prognosis.

Conclusions

1. Video EEG represents a cornerstone in the classification of epilepsy syndromes and helps in selecting appropriate treatment and improving the prognosis of seizures.

2. Neuropsychological activation protocols are useful tools for inducing interictal discharges that have important implications for the diagnosis and classification of epilepsy syndromes like frontal lobe epilepsy.

Recommendations

1. monitoring should be the mainstay in the diagnosis of seizures, in addition to routine EEG.
2. Proper use and application of activation procedures like hyperventilation, photic stimulation, and sleep deprivation are very helpful in exciting interictal epileptiform discharges.
3. Adoption of neuropsychological protocols as one of the activation procedures in video EEG monitoring to augment the triggering effect of different provocative techniques
4. A similar study should be done on pediatric samples and above 63 years of age.

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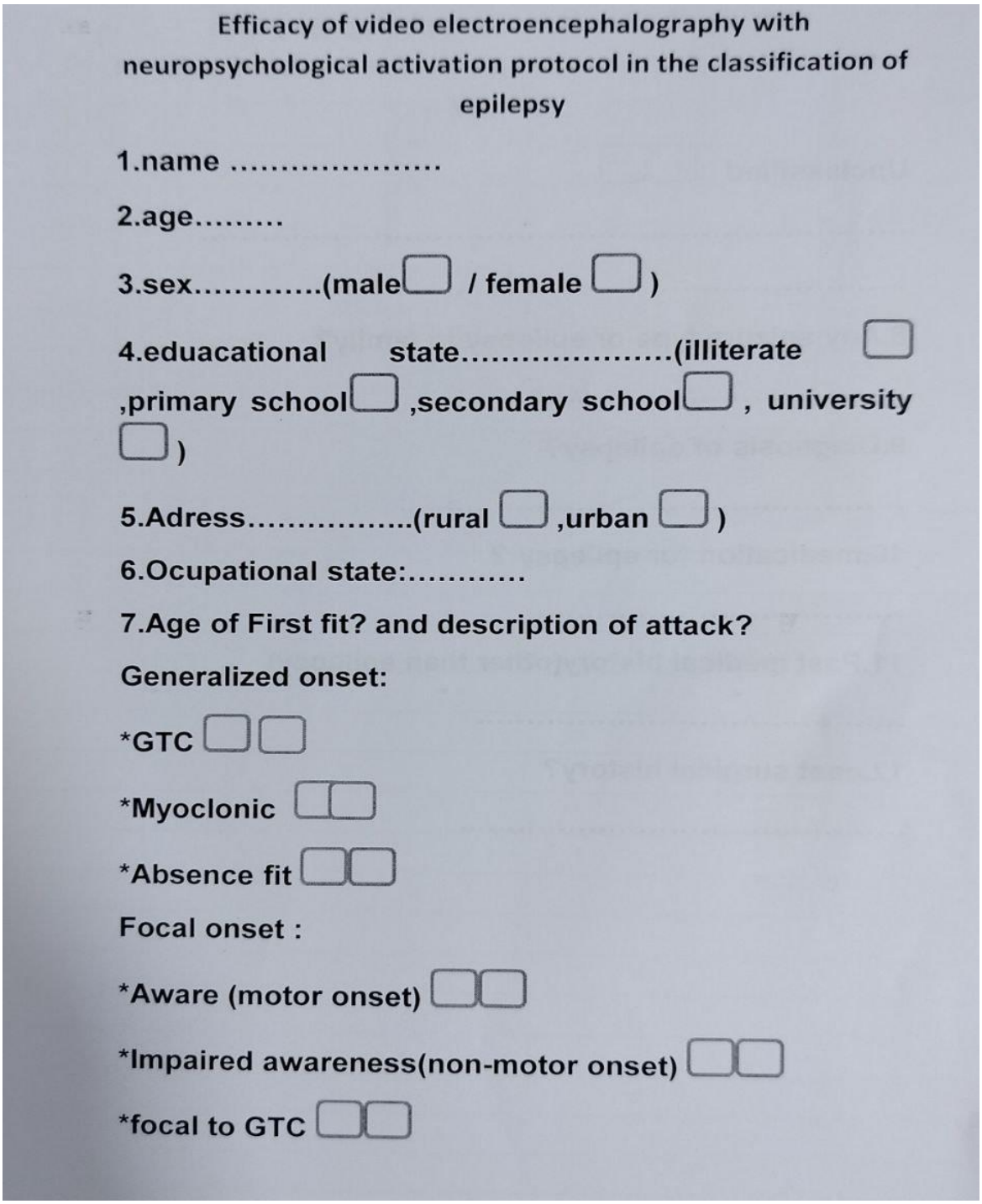
Appendages



Efficacy of video electroencephalography with neuropsychological activation protocol in the classification of epilepsy

1.name .....

2.age.....

3.sex.....(male☐ / female☐)

4.eduacational state.....(illiterate ☐ ,primary school☐ ,secondary school☐ , university ☐)

5.Adress.....(rural ☐ ,urban ☐)

6.Ocupational state:.....

7.Age of First fit? and description of attack?

Generalized onset:

*GTC ☐☐

*Myoclonic ☐☐

*Absence fit ☐☐

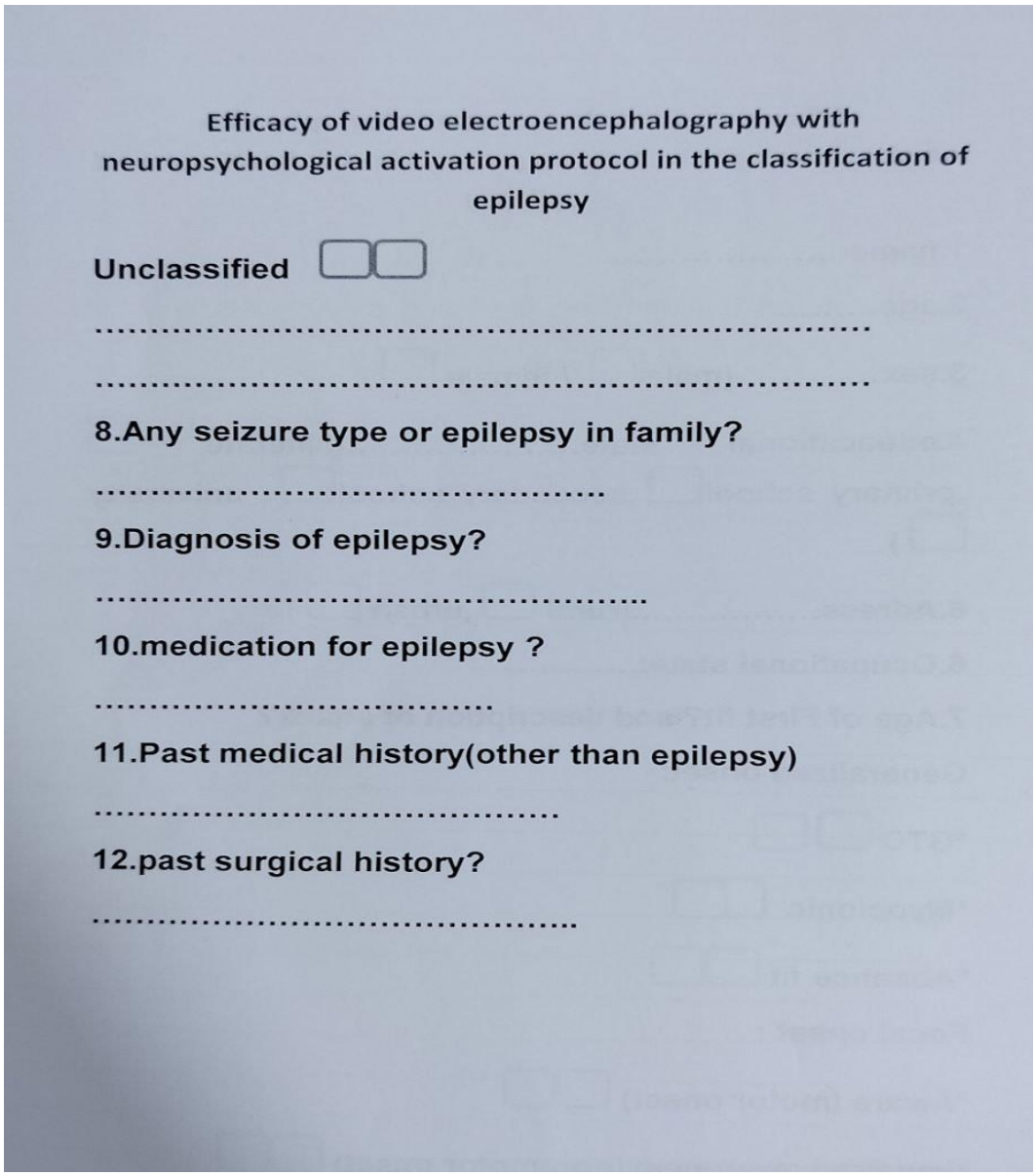
Focal onset :

*Aware (motor onset) ☐☐

*Impaired awareness(non-motor onset) ☐☐

*focal to GTC ☐☐

Figure (A)



Efficacy of video electroencephalography with neuropsychological activation protocol in the classification of epilepsy

Unclassified ☐☐

……

……

8.Any seizure type or epilepsy in family?

……

9.Diagnosis of epilepsy?

……..

10.medication for epilepsy ?

……

11.Past medical history(other than epilepsy)

……

12.past surgical history?

……..

Figure(B)

Figure: (A and B): paper as with question of demographic data and patient history.

الخلاصة

الصرع، أحد أكثر الاضطرابات العصبية المزمنة شيوعًا، ويؤثر على حوالي 50 مليون شخص في العالم. يتم تشخيصه سريريًا بناءً على علم وصف النوبات وأيضًا نتائج تسجيل تخطيط كهربائية الدماغ. يفشل تخطيط كهربائية الدماغ الروتيني أحيانًا في تسجيل إفرازات الصرع بين النوبات لدى بعض المرضى، خاصة كبار السن والذين يعانون من نوبات بؤرية، لذلك يمثل تخطيط كهربائية الدماغ الفيديوي الأداة القياسية الذهبية للتشخيص على أستخدام تخطيط كهربائية الدماغ الروتيني، مع استخدام أساليب منشطه لزيادة إنتاجية التفريغ النوبي ,مثل فرط التنفس، والتحفيز الضوئي المتقطع، والحرمان من النوم. بروتوكول التنشيط العصبي النفسي هو بروتوكول تم استخدامه مؤخرًا للحث على التنشيط القشري لاستحضار الافرازات بين النوبات من خلال مجموعة متنوعة من المهام المعرفية مثل القراءة والكتابة والرياضيات والرسم والبناء المكاني.

تهدف هذه الدراسة إلى اختبار مدى فائدة مراقبة تخطيط كهربائية الدماغ الفيديوي في تصنيف النوبات والتحقق من فعالية بروتوكولات التنشيط العصبي النفسي في تحفيز الافرازات الصرعية.

هذه دراسة عشوائية أجريت في جناح الأمراض العصبية / غرفة تخطيط كهربائية الدماغ الفيديوي في مستشفى الإمام الصادق التعليمي في مدينة الحلة خلال الفترة من سبتمبر 2022 حتى أبريل 2023. وشملت الدراسة 47 مريضا توزيعهم العمري بين 12 سنة حتى 52 سنة (25 ذكر و22 أنثى). يتم تجنيد المرضى من غرفة تخطيط كهربائية الدماغ الفيديوي في جناح الأعصاب بعد تشخيص إصابتهم بالصرع من قبل طبيب أعصاب ذي خبرة. يخضع جميع المشاركين، بعد الحصول على إذن شفهي، لتقييم سريري شامل مع التركيز على التقييم العصبي الذي يجريه طبيب الأعصاب، ثم يخضعون لتسجيل تخطيط كهربائية الدماغ الفيديوي في مراحل مختلفة مثل إغلاق العين، وفتح العين، وفرط التنفس، والتحفيز الضوئي المتقطع، وبروتوكول التنشيط العصبي النفسي المتبع. عن طريق تخطيط كهربائية الدماغ أثناء النوم إن أمكن. استمر التسجيل لمدة تتراوح بين 2 إلى 6 ساعات، ثم تم تحليل تسجيلات تخطيط كهربائية الدماغ إلى جانب تسجيلات الفيديو بواسطة طبيب أختصاص فسلجه عصبية سريرية والذي كان لا يعلم عن تاريخ المريض والتشخيص.

كشفت هذه الدراسة أن النسبة المئوية للمرضى الذين لديهم إفرازات بين النوبات من خلال تسجيل كهربائية الدماغ الفيديوي كانت حوالي 91.48%، مع نتائج أكثر، تم تصنيف النوبات وفقًا للرابطة الدولية لمكافحة الصرع-2017 إلى نوبات بؤرية (11 مريضًا) ونوبات بداية معنده (36 مريضًا). شاركت مراقبة تخطيط كهربائية الدماغ الفيديوي في تغيير التشخيص الأولي لنوع النوبات لدى 27 مريضًا (57.45%). أيضًا، حدث

ل ستة مشاركين (12.6٪) نوبة صرع في مراحل مختلفة من التسجيل. يحفز بروتوكول التنشيط النفسي العصبي الإفرازات بين النوبات في حوالي 72.3% من المرضى، بينما تعتبر الرياضيات (الحسابات المكتوبة) هي التقنية الأكثر شيوعًا التي تحفز الإفرازات الصرعية بنسبة 29.78%.

ومن خلال نتائج الدراسة نستنتج أن تخطيط كهربائية الدماغ الفيديوي يمثل حجر الزاوية في تشخيص وتصنيف متلازمات الصرع، وأنه يساعد في اختيار العلاج المناسب وتحسين تشخيص النوبات، وأنه يساعد في تغيير تشخيص نوع الصرع وتحديد التشخيص النهائي يعتمد على تسجيل الفيديو وعلم وصف النوبات. يعتبر بروتوكول التنشيط العصبي النفسي جزءا هاما من إثارة الإفرازات النوبية، وخاصة في النوبات البؤرية، وقد يحفز نوبات الصرع أثناء التسجيل، لذلك قد يمثل أداة مفيدة في إثارة الإفرازات النوبية التي لها دور مهم في تشخيص وتصنيف متلازمات الصرع.