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Research Article

Electroencephalogram and Visual Evoked Potential Studies in Patients with Stroke

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ABSTRACT

Stroke or cerebrovascular accident occurs when the blood supply to the brain is cut off (an ischemic stroke) or when a blood vessel bursts (a hemorrhagic stroke). Most strokes are of the ischemic type. Without oxygen, brain cells begin to die. death or permanent disability can result. High blood pressure, smoking,D.M, and having had a previous stroke or heart attack increase a person's chances of having a stroke. The aims of this study: Evaluate the role of electroencephalography and visual evoked potential in patients presented with stroke. Determine the electroencephalographic abnormalities in stroke patients. Evaluate the clinical manifestations and medical history of patient with stroke. This study is a case-control study dealing with a total of 170(male and female) subjects, 85 of them as group presented with stroke and the other 85 considered asa control group. The electrophysiological tests were done at the neurophysiology unit of Mirjan Teaching center in Babylon City, during the period from 1th/12/ 2015 until 20th / 5/2016.Electroencephalography and Visual evoked potential were performed for the patients and the control in parallel.This study shows the differences between patients with stroke and control by EEG changes there were significant differences between patients and control by EEG changes. There were 35% of stroke patient presented with abnormal EEG changes ,While 26%of stroke patient presented with abnormal VEP. The purpose of the study was to compare sensitivity and specificity of these two analytical procedures (EEG and VEP) in the diagnosis of stroke. The sensitivity and the specificity of EEG in stroke The results showed a sensitivity of35.3% and a specificity of 97.6%.p value < 0.01 is highly significant.The sensitivity and the specificity of VEP in stroke The results showed a sensitivity of 25.9% and a specificity of 100% p value < 0.01 is highly significant.The EEG abnormal findings in stroke patients were (35%) of all patient group (68%) of them were generalized while (32%)were partial seizure.The distribution of different EEG abnormalities in stroke patients were (slow wave 48%,spike wave26%,poly spike wave13% and sharp wave13%).The VEP abnormal findings in stroke patients were(26%) of allpatient group, the majority of abnormal VEP findings were prolonged latency of P100, P75 and P145 respectively.There were significant differences between stroke patients and control group regarding the clinical manifestations and medical history (DM, Headache, Dysarthria , Visual disorder, Facial weakness, dizziness hypertension and Hemiphgia.

Keywords: Electroencephalogram

INTRODUCTION

A Stroke or cerebra vascular accident (CVA) occurs when blood supply to part of the brain is disrupted causing brain cells to die[1]. Stroke is considered as the second most common cause of death and a major cause of disability worldwide Because of the ageing population the load of stroke is likely to increase especially in developing countries during the next 20 years[2]. The WHO defines stroke as the sudden onset of focal neurological signs of presumed vascular origin lasting longer than 24 hours or causing death[3]. When the blood supply to a part of the brain is interrupted, ischemia damages or kills the cells in the area, producing the signs and symptoms of a stroke. Strokes are classified into two major categories: ischemic and hemorrhagic. Ischemic strokes are caused by blockages of the blood supply, while hemorrhagic strokes result from an abnormal vascular configuration or break of a blood vessel. Strokes caused by ischemia represent 87%, while the rest caused by hemorrhage. Some hemorrhages develop inside areas of ischemia ("hemorrhagic transformation"). It is unidentified how many hemorrhages really start as ischemic stroke[4]. The World Health Organization has estimated that each year15 million people suffer a stroke internationally of from 5 million die and another 5 million are left permanently disabled[5]. Regarding the diagnosis of the disease is based in clinical exam, history of patient and image techniques like computerized tomography scan (CT scan), magnetic resonance images (MRI) and other investigation methods are very important such as: some blood tests, electrocardiogram (ECG), Doppler ultrasonographer, echocardiography and Electroencephalography (EEG)[6]. Evoked potentials are usually not employed in diagnosis

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Table 1: Distribution with smoking habits

Variables	Frequency (%)	Chi-square	P-value
Smoking habit			
Smokers	57	11.642	0.0006
Non-Smokers	(67.06%)		
Total	28		
	(32.94%)		
	85		
	(100.0%)		
Hypertension			
Yes	63	23.271	0.00001
No	(74.12%)		
Total	22		
	(25.88%)		
	85		
	(100.0%)		
BMI			
Normal weight (18.5-24.9 kg/m^2)	12 (14.11%)	25.782	0.000025
Overweight (25-29.9 kg/m^2)	47 (55.29%)		
Obese (≥ 30 kg/m^2)	26 (30.58%)		
Total	85 (100.0%)		
DM			
Yes	42(47.1%)	52.308	0.001**
No	43(52.9%)		

BMI=Body Mass Index

Table 2: The Distribution of patient with sign and symptoms.

VVariabla	Patients with stroke(%)	*P* (Values)
Headache		
Present	66(77.6%)	0.001**
Absent	19(22.4%)	
Dyasarthia		
Present	43(50.6%)	0.001**
Absent	42(49.4%)	
Visual disorder	43(50.0%)	0.001**
Present	42(49.4%)	
Absent		
Facial weakness	42(49.4%)	0.001**
Present	43(50.6%)	
Absent		
Dizziness		
Present	79(92.9%)	0.001**
Absent	6(7.1%)	
Hemiphgia		
Present	52(61.17)	0.001**
Absent	33(38.82)	

*P value ≤ 0.001 is significant

of stroke, but they are very useful in the evaluation of the patient's functions and disabilities. This information is very important in the patient's rehabilitation and rapid progression to daily activities[7] Thrombolytic, Ant platelet. Anticoagulant. Glutamate and the NMDA receptor antagonists, GABA antagonists, Free radical scavengers and Apoptosis inhibitor are main lines for stroke treatment.

MATERIALS AND METHODS

Subjects

This study is a case-control study carried out in Mirjan Teaching center in Babylon city. During the period from December 2015 to May 2016.The study included 85 patients with stroke and 85 person as control group. Apparently healthy subjects as control group were crossed matched in age and sex with patient group. EEG and VEP study were done to all subjects involved in this study. Range of age (35±65) and male (39) female (46).

Inclusion criteria

Patients were presented with chronic ischemic stroke.

Exclusion criteria: Primary epilepsy, Brain infection, Brain Trauma, Multiple Sclerosis, Optic nerve disorders, Brain tumor, Hemorrhagic stroke, Brain malformations, Endocrine disorders, Other central neurological disorders, TIA and Migraine Methods: All the subjects were approving by: Electrophysiological tests: Electroencephalography (EEG). Visual evoked potential (VEP).Test procedures were first interpreted in Spartan to the subjects to ease a good cooperation. The room temperature was monitored and maintained between 25-28 through both EEG and VEP test methods.

Electroencephalography (EEG) study

EEG Procedure: Electrical impulses in the brain are evaluated using an EEG. The test measures this electrical activity through several electrodes placed on patient's scalp. An electrode is a conductor through which an electric current can pass safely. The electrodes transfer information from brain through wires to an amplifier and a machine that measures and records the data. Visual Evoked Potentials (VEPs) Study: Visual Evoked Potential test was carried out in a dark, quite room, with the subjects sitting comfortably on a chair, and advised not to move or blink continuously during the test in order to decrease muscle contraction artifacts from eyes and skeletal muscles which blur the evoked potential waves, thus it is of paramount importance to avoid such artifact.

Statistical Analysis

All statistical analysis was obtained using the Statistical Package for Social Science (SPSS) version 20.0 and Microsoft Excel (2007) software. Descriptive statistics for all data of each set were expressed as mean ± SD, and the percent of abnormal value in any test was calculated as above or below the (mean ± SD) of the normal values for the matched control group. Data from each patient and control group were compared using independent (t) test, and analysis of (Chi-square) to test the variation significance for each parameter between different groups. The level of statistical significance was defined as (P) value ≤0.05, which was obtained by comparing the calculated t-value to the tabulated t-value at 95% confidence interval.

Table 3: Differences of Patients with stroke and Control by EEG Findings.

Variable	Study group		X2	p- value
	Patient with stroke No. & (%)	Control No. &(%)		
Normal EEG	55(64.4%)	85	154.122	0.001**
Abnormal EE	30(35.3%)			

*p value ≤ 0.001 is significant,EEG = Electroencephalography

Table 4: Differences of Patients with stroke of both sides by VEP latency.

Variable	Study Groups		χ^2	P value	Mean	Std. Deviation
	patient (%)	Control (%)				
RT Latency wave1						
Normal < 75 (m.sec)	50 (58.82)	85 (100)	103.12	≤0.05	61.675	7.70
Abnormal ≥ 75 (m.sec)	35 (41.17)	0 (0)			74.589	13.91
RT Latency wave2						
Normal < 110 (m.sec)	55 (64.7)	85 (100)	108.655	≤0.05	88.759	6.98
Abnormal ≥ 110 (m.sec)	30 (35.29)	0 (0)			108.827	19.3
R T Latency wave3						
Normal < 145 (m.sec)	64 (75.29)	85(100)	125.6	≤0.05	121.1	9.0
Abnormal ≥ 145(m.sec)	21 (24.7)	0 (0)			137.8	20.1
LT Latency wave 1						
Normal < 110 (m.sec)	58 (68.23)	77 (90.58)	79.194	≤0.05	63.4	7.89
Abnormal ≥ 110 (m.sec)	27 (31.76)	8 (9.41)			73.4	14.5
L T Latency Wave 2						
Normal < 75 (m.sec)	60 (70.58)	81(95.29)	99.025	≤0.05	93.2	11.0
Abnormal ≥ 145 (m.sec)	25 (29.41)	4 (4.7)			106.7	19.0
LT Latency wave3						
Normal < 145 (m.sec)	59 (69.41)	85 (100)	115.083	≤0.05	124.4	8.9
Abnormal ≥ 145 (m.sec)	26 (30.58)	0 (0)			133.1	28.9

*p value ≤ 0.05 is significant , RT = Right, LT = Left, $\chi 2$ = Chi-Squa

RESULT

The Distribution of Patients by Medical History: In this study, the distribution of patients by medical history includes, (67.06%) of patients are non-smokers, (25.88%) of patients do not have hypertension. The overall mean BMI was (29.17±4.97) kg/m2 and (30.58%) of patients are obese, as shown in table (1):

The Distribution of Patient with Sign and Symptom in Stroke

This study shows the differences between patients with stroke and control associated with clinical symptoms, there were significant differences between patients and control byHeadache**,** Dyasarthia**,** Visual disorder**,** Facial weakness, dizziness and hemiphgia as shown in table (2).

Differences of Patients with stroke and Control by Electroencephalographic Findings

This study shows the differences between patients with stroke and control by EEG changes there was significant differences between patients and control by EEG as show in table (3).

The Association of EEG Finding of stroke Patients

In this study the association of EEG Finding of stroke patients include (35%) of stroke patients with abnormal EEG, as shown in Figure(1)

The Distribution of Different EEG Abnormalities in Stroke

This study shows the distribution of different EEG abnormalities in stroke. Slow 48%, spike 26%, poly spike 13% and sharp13%. As shown in Figure (2)

Types of EEG changes in Stroke

This study shows the distribution of different type of EEG abnormalities in stroke.68% generalized and 32% partial as show in figure (3).

Differences of Patients with stroke and Control Groups by VEP latency

Table (4) shows the differences of patients with stroke and control groups by VEP latency. There were regarding the latency of wave I, П, ш.

The Association of VEP Finding of stroke Patients

In this study the association of VEP Finding of stroke patients include (26%) of stroke patients with abnormal VEP , as shown in Figure(4).

EEG of stroke patient group in correlation to control group

The purpose of the study was to compare sensitivity and specificity of the procedure (EEG) in the diagnosis of stroke170 patients with stroke and control were examined in order to demonstrate the sensitivity and the specificity of EEG in stroke The results showed a sensitivity of35.3% and a specificity of 97.6%.p value < 0.01 is highly significant. As show in Table (5).

The VEP of stroke patient group in correlation to control group

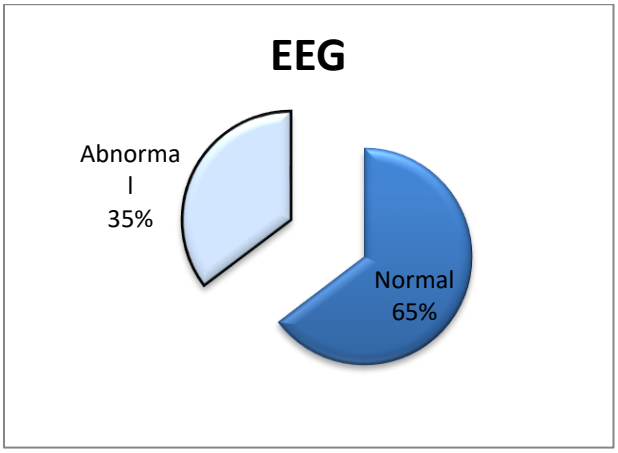

Figure 1: The Association of EEG Finding of stroke Patients**.**

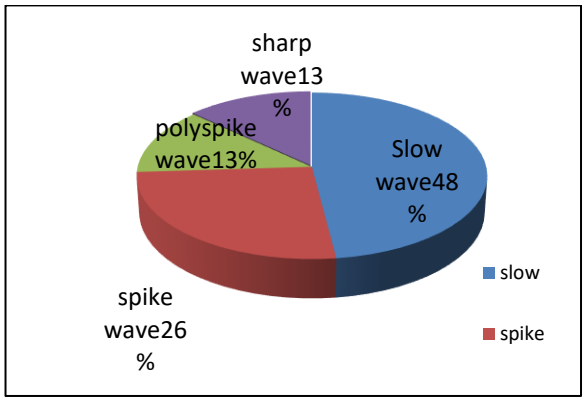

Figure 2: The Distribution of Different EEG Abnormalities in Stroke.

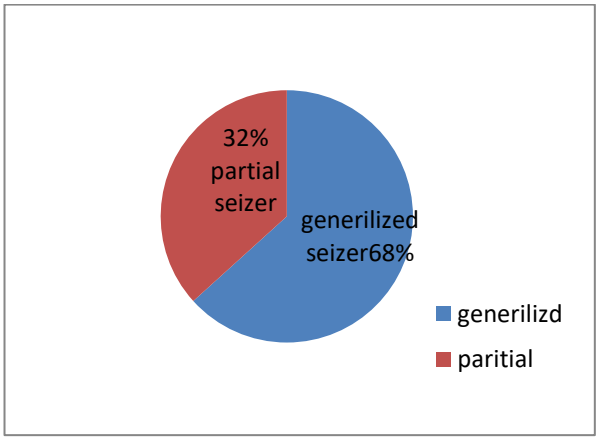

figure 3: Types of EEG changes in Stroke.

The purpose of the study was to compare sensitivity and specificity of the procedure (VEP) in the diagnosis of stroke170 patients with stroke and control were examined in order to demonstrate the sensitivity and the specificity of VEP in stroke The results showed a sensitivity of 25.9% and a specificity of 100%.p value < 0.01 is highly significant. as show in table (6).

DISCUSSION

In this study the result of stroke with patients medical history of study groups outlined in tables 1 show that hypertension does have association with the development of stroke Previous studies reported different results about the relationship between BP levels and the clinical outcomes in patients with ischemic stroke. Some studies reported that a high BP was associated with a poor functional outcome[8]**.** In contrast; other studies suggested that a high BP was favorable with regard to the outcome[9]. In this study, smoking is related to prevalence of stroke Although data from some studies suggest a positive relationship between smoking and stroke[10] Smoking is a major cause of stroke in people under 65 years old[11] Other studies have failed to confirm this relationship[12] To consider the BMI and stroke relation quantitatively, particularly the extent to which the relation is mediated through the effects of BP on stroke, further approximate correction is also needed for "regression dilution" bias[13] low BMI may reflect reduced lean mass related to inactivity due to reduced mental and physical health[14]. Several prospective studies have reported on the relation between BMI and stroke, but the findings have been inconsistent. Some have reported a positive linear association with total stroke[15] whereas others have reported no relation[16] High blood pressure is the most prevalent modifiable risk factor for stroke[17] Hypertension is common in patients admitted for an acute ischemic stroke, and a transient blood pressure rise whereas in patients with hemorrhagic stroke hypertension in the acute phase is more severe than the usual blood pressure elevation[18] Diabetes mellitus is an independent risk factor for cardiovascular diseases as well as in patients with stroke, it is an independent risk factor for complications during hospitalization[19] DM is associated with a 3.2-fold increase in the risk of cerebral ischemia due to cerebrovascular reactivity impairment secondary to damage to small arteries(20)the consequences of diabetes are negatively affected by the profile of diseases accompanying it, these are independent risk factors for stroke and are part of the metabolic syndrome. There is general agreement that both the etiology and path mechanism of stroke differ depending on age and gender[21]. This study show significant association stroke patient in table (2). patients with stroke presented with by Headache**,** (77.6%),Dyasarthia (50.6%)**,** Visual disorder**(**50.0%),Facial weak(49.4%), dizziness(92.9%), and Hemiplegia(60.0%).but patients Absent clinical sings were presented with DM(52.9%), Headache**(**22.4%),Dysarthria(49.4%)**,** Visual disorder(49.4%)**,** Facial weak(50.6%), dizziness(7.1%), Hemiplegia(40.0%).(Patricia *et al,* 2008)**.**(22)found that 62% of their stroke patients did not know the signs of a stroke. the stroke databases have reported that hemi paresis, paresthesia, and speech abnormalities are the most common neurological abnormalities occurring in patients with ischemic stroke[23] results were found in our study. Although "weakness (unilateral)" was the most commonly recognized symptom of stroke in our population, only 26% of our patients noted it. Headache is a common symptom in stroke, but the incidence rate is not known. Numerous reports have dealt with headache caused by different cerebra vascular lesions[24] but only a

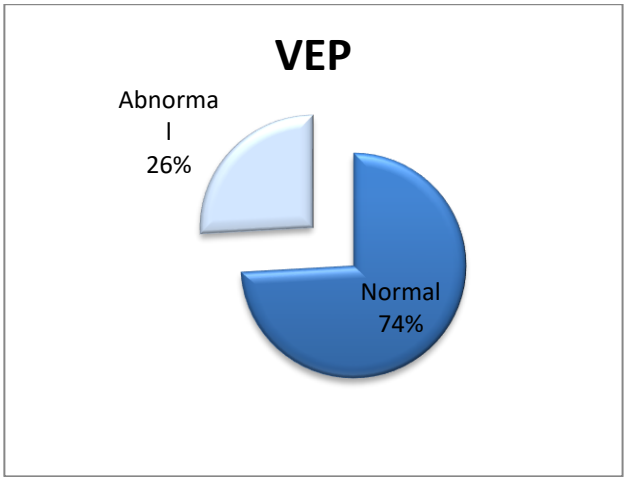

Figure 4: The Association of VEP Finding of stroke Patients.

few prospective studies have been done[25]. This study confirms that headache is a relatively common phenomenon in cerebrovascular disease. The present frequency of headache in infarction of 26% is similar to that reported in other prospective studies[26] Strokes causing vertigo or dizziness are mostly located in the lateral brainstem and cerebellum[27] As a result, primary motor and sensory pathways are usually intact. The lack of hemi motor involvement is likely one of the major reasons that these "vestibular strokes" are not recognized in the ED. Two studies from the same ED population-based sample found that strokes are missed initially in 35% of those presenting vestibular symptoms[28] versus 4% of those presenting motor symptoms(Neurological exams in stroke patients presenting vertigo or dizziness are non-focal in >80%, even when performed by an experienced neurology-trained neurootologist, and even when the highest-risk-for-stroke population is studied[29]. The study reporting the highest proportion of stroke/TIA focused only on subjects with acute-onset vertigo[37]**.** The most common causes of vertigo and dizziness are benign peripheral vestibular disorders, whereas acute imbalance without vertigo or dizziness is usually caused by a cerebella stroke, particularly within the superior cerebella artery distribution[30] and not the result of a peripheral vestibular disorder. Vertigo and dizziness can be caused by acute brain stem or cerebella stroke, but the statistical association of these symptoms with stroke is less than the association of imbalance with stroke as a result of the relative infrequency of stroke causing vertigo or dizziness compared with non-stroke causes (i.e. peripheral vestibular disorders).This study shows the differences between patients with stroke and control by EEG changes there was significant differences between patients and control by EEG. p value ≤ 0.001 is significant as show in table (4.3)In this study the association of EEG Finding of stroke patients include (35%) of stroke patients with abnormal EEG ,as shown in Figure(4.2).Normal EEG patterns represent synchronized oscillations of large groups of neurons; synchrony of these oscillations is more dependent on intracortical interactions during waking and more dependent on thalamocortical interactions during sleep[31] In general, pathologic EEG findings may reflect dysfunction originating in the neocortical neurons that generate the signal, or dysfunction originating in distant neurons and "projected" to the neocortical generators, or both[32] Epileptiform EEG abnormalities represent synchronized paroxysmal depolarization shifts (PDSs) in cortical neurons, a cellular phenomenon that was reviewed in part 1 of this series[33]. Acute seizures and status epileptics (SE) are common in all types of acute brain injury. In the Neurologic Intensive Care Unit (Neuro-ICU), up to 34% of patients undergoing EEG monitoring have no convulsive seizures (NCS), and 76% of these cases are no convulsive SE[34] Even after excluding all patients with any clinical evidence or history of seizures, still 8% of comatose patients have NCS[35]. NCS have been described in 27% of patients with altered consciousness[36] 48% of patients after the termination of generalized convulsive SE,4 22% with severe traumatic brain injury (TBI)[37], 6% with ischemic stroke[38], After discharges are interictalepileptiform activities that may consist of single or rhythmically or irregularly repetitive spike-wave, sharp wave-slow wave, or polyspike-wave discharges; less often, they consist of paroxysmal fast activity that appears relatively monorhythmic[39] Generalized seizures involve both cerebral hemispheres, with ictal discharges of various forms of generalized spike-wave or GPFA patterns from onset when the EEG is not obscured by artifacts. Generalized seizures can be divided into generalized tonic-clonic, tonic, tonic, clonic, myoclonic and absence seizures. Generalized seizures usually are associated with EEG changes with scalp EEG recording. In a secondarily generalized seizure, a focal onset often is seen at the beginning of the seizure, if the background is not obscured by artifacts. However, the focal on set may not be obvious if there is rapid spread (rapid secondary bilateral synchrony[40] simple partial seizures do not have a clear electrographic correlation in 60% to 90% of cases[41] frontal lobe seizures often do not have a clear EEG correlate due to artifacts in complex partial seizures, making this a significant challenge for clinicians in pre surgical evaluation[42]. Occipital- and parietal-onset seizures are less common than temporal lobe seizures, and may be simple partial seizures, complex partial, or secondarily generalized seizures, usually with clear localization on scalp EEG for diagnosis, although intracranial recordings are necessary for surgical planning[43]. Table (4) show the differences of patients with stroke and control Patient groups by VEP latency. There were regarding the latency of wave I, II, III. In this study, the association of VEP Finding of stroke patients include (26%) of stroke patients with abnormal VEP, as shown in Figure(4.4).Visual evoked potentials (VEPs) are a series of signals representing the responses of the visual occipital cortex to visual stimuli including flash and pattern stimuli, and can be used as one of the objective non-invasive neuro physiological parameters in the assessment of the functions of visual organs, visual pathways and the optical central nervous system[44]. Evoked Potentials (EP) are voltage variation that appears

Table 6: The VEP of stroke patient group in correlation to control group.

		patients with stroke	healthy volunteers	Total
VEP	Positive	22	0	22
	Negative	63	85	148
Total		85	85	170
Accuracy		=((22+85)/170)×100	=62.9 %	
Sensitivity		=(22/(85))×100	=25.9%	
Specificity		=(85/(85)×100%	= 100%	
PPV		=(22/(22)×100%	= 100%	
NPV		=(85/(148))×100%	= 57.4.1%	
P value			P< 0.01**	

**p value < 0.01 is highly significant

Table 5: The EEG of stroke patient group in correlation to control group.

		patients with stroke	healthy volunteers	Total
EEG	Positive	30	2	32
	Negative	55	83	138
Total		85	85	170
Accuracy		=((30+83)/170)×100	=66.5 %	
Sensitivity		=(30/(85))×100	=35.3%	
Specificity		=(83/(85)×100%	=97.6%	
PPV		=(30/(32)×100%	=93. 8%	
NPV		=(83/(138))×100 %	=60.1%	
P value			P< 0.01**	

P value < 0.01 is highly significant

in cortical and sub cortical structures of the nervous system in relation with an external stimulus or internal processing. They could be register by superficial electrodes in the skin or scalp by no invasive procedure[45]. Stroke can cause abnormalities at nerve optic level or cortical blindness[46]. Ischemic ocular syndrome is a disease caused by vascular disease at a level of common or internal carotid artery. It diminishes perfusion in retinal center artery, and can cause visual defect and nerve optic atrophy. In this case VEP is very useful because it study conduction of optic nerve fibers, which could be damage. Usually VEP show enlargements of P100 wave latency or amplitude diminish if there is axonal lesion of the nerve fibers. It has been reported by[45] and other authors described VEP abnormalities in stroke that affect visual cortex. In cortical blindness due to stroke VEP can show absence of all components in some cases, but in others can show normal P100 response, its occurs in patients who have retino geniculate fibers and parts of cortical areas functional. This means that a surviving neuronal pool in area 17 generates a P100 potential, but is not sufficient for visual perception[46] On the other hand reported utility of VEP in diagnosis of conscious disturbances, especially brain death. Also can measure another Parameters to complete study [47-49].

CONCLUSIONS

The EEG abnormal findings in stroke patients were (32%) of all patient group (68%) of them were generalized while (35%) were partial seizure. The distribution of different EEG abnormalities in stroke patients were (slow wave 48%, spike wave26%, poly spike wave13% and sharp wave13%). The VEP abnormal findings in stroke patients were(26%) of allpatient group, the majority of abnormal VEP findings were prolonged latency of P100, P75 and P145 respectively. There were significant differences between stroke patients and control group regarding the clinical manifestations and medical history (DM, Headache, Dyasarthia , Visual disorder, Facial weakness, dizziness hypertension and Hemiphgia.

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