

Detection of Retinopathy in Diabetes II Patients Using Visual Evoked Potential

¹Sofia Bobby J, ²Nithya M V, ³Naveen S, ⁴Akshaya U G

¹Associate Professor, Jerusalem College of Engineering, Chennai – 100

^{2,3,4}Students, Jerusalem College of Engineering, Chennai – 100.

Corresponding author

Sofia Bobby J. Email: send2sofia@yahoo.co.in

Abstract

Introduction and Aim: Diabetes is a metabolic condition having higher blood sugar level than normal. Retinopathy refers to the damage of retina in the eye which leads to vision impairment. Diabetic Retinopathy is a degradation of the blood vessels in the retina that usually affects eyes, so that the person may loss vision in later periods for the Diabetic cases. Diabetic Retinopathy, is a condition in which layer of the retina gets damaged due to diabetes mellitus. This paper aims for the early detection of retinopathy with the help of visual evoked potential and to reduce its complications.

Materials and Methods: In this article, visually evoked potential (VEP) signal is acquired with a flash light as a stimulus to the subject and maintain the patient results as a database. VEP signal is taken for 30 subjects in control group and 30 subjects in diabetic group. The classification is based on P100, N75 and N145 latency.

Results: The obtained result shows that there is a delay in P100 latency in Diabetic cases. Significant association was obtained between duration of diabetes mellitus and P100 latency. Then SVM classifier is used to classify between the retinopathy and non-retinopathy patients. By using the classifier the process becomes easy whereas it is difficult in the manual results.

Conclusion: This study compares VEP among 30 diabetics and equal number of healthy controls. It was observed that P100 latency was prolonged in diabetics patients compared to controls. These changes are responsible for the changes in latency of optic nerve responses. P100 latency in the retinopathic cases is about 120 or above and in non-retinopathic cases it is about 114. Since P100 prolongation in diabetes is a remarkable sign of Diabetic Retinopathy, VEP assessment must be done for all diabetic patients to identity their visual defects earlier.

Key words: Diabetes, Retinopathy, VEP, SVM Classifier

Introduction

The human eye gather light from the encircle environment, regulates its intensity, focuses it through an assembly of lenses to form an image, turn this image into a set of electrical signals, and send out these signals to the brain through complex neural pathways

that connect the eye via the optic nerve to the visual cortex.

Eye diseases like macular degeneration, glaucoma and cataracts can cause vision problems. Also in some patients the retinopathy condition can cause the loss of vision. It is mainly due to the tiny leakage in the retinal blood vessels. This condition can

lead to so many complications such as heart and kidney related diseases, neuropathy, urinary problems, eye problems etc. Therefore diabetic patients are prone to develop peripheral and autonomic neuropathy. Diabetic retinopathy (DR) is a diabetes complication that affects eyes. It is caused by blood vessel damage at the retina. This condition results in the degradation of the blood vessels in the retinal layer, It has no symptoms may be some slight vision problems but later on it can cause blindness.

Visual Evoked Potential is a sensitive, noninvasive, painless test to spot any optic nerve damage. Recording VEP is a highly reliable and reproducible method for diagnosing any defects in the anterior visual pathways. Any abnormalities in the Visual pathway can be detected by VEP. Delayed VEP latencies can spot various clinical conditions such as Optic neuropathy, multiple sclerosis, retro bulbar neuritis; papillitis. Diabetes mellitus is a condition in which cells cannot use glucose for energy.

LITERATURE SURVEY

The comparative study between amplitudes, latency P100 of VEP in type 2 diabetes mellitus with that of healthy controls. The mean value of P100 latency and amplitude were compared between the diabetes patients and controls and this study had concluded that prolongation of P100 latency is a sign of optic neuropathy (1). Change in Visual evoked potential was recorded for 15 healthy volunteers and 25 diabetes patients. Diabetes patients were grouped according to their blood glucose level. This study concluded that P100 latencies were observed to be more in poor glycemic control which further proves that diabetes mellitus has an effect on changes in VEP(2).

A delay in VEP latency in Diabetes Patients can be described to dysfunction of retinal structures. The study had 40 normal controls, 40 Diabetes mellitus patients without Retinopathy and 40 Diabetes mellitus patients with Retinopathy. The mean P100 latency had

significant difference whereas mean amplitude and mean N75 latency had no significant changes (3). The changes in Visual evoked potential in patients with Diabetes mellitus and VEP was recorded in 116 subjects (64 diabetes without retinopathy and 52 healthy controls). P100 latency, amplitude and interocular latency differences were compared between controls and diabetes patients. This study had concluded that VEP responses are different in diabetes patients before the onset of Retinopathy (4). PVEP was recorded in 40 diabetes patients and 40 controls. VEP was recorded for all patients and controls. P100 wave latency was longer in diabetes patients than controls. Reduction in N75 wave was found in diabetes patients (5)

METHODOLOGY

The Visual Evoked Potential (VEP) is a non-invasive neuro physiological examination for evaluating the integrity of neural pathways, responsible for vision. Automatic classification between the retinopathic condition and non-retinopathic can be done instead of manual results. The block diagram for the VEP recording is shown figure 1.

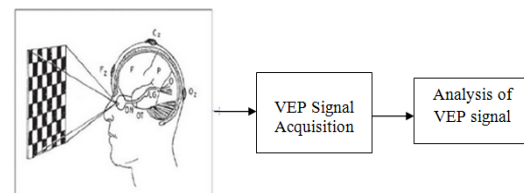


Figure 1 Block Diagram of VEP Acquisition

VEP amplifier setup is used to acquire the VEP signal. The software here used is 'ALLENERS'. The evoked potentials are produced by central nervous system and it implements one visual activity or auditory activity. The subjects for this recording are above the age of 30 because we are aiming for finding out the diabetic condition. The recorded signal is export in the excel sheet. Then it is classified using SVM classifier in MATLAB.

ELECTRODE PLACEMENT

A common method for placing the scalp electrodes is the '10-20 electrode system'. The electrode is correctly placed on the mid occipital line (Oz). It is at 5cm just above the inion region and 5cm lateral from the location of the occipital electrodes (O1, O2). In VEP recording, the reference electrode is placed at the forehead region and the ground electrode is placed at auricular region. Figure 2 shows electrode placement of VEP.

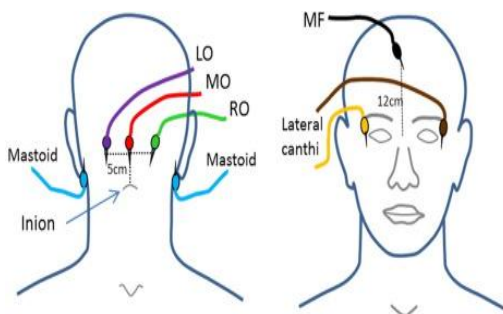


Figure 2 Electrode Placement

The impedance of the electrodes should be lesser than 14 ohms in order to acquire the accurate signal.

VEP SETUP

Three types of stimuli are used for the VEP measurement such as checker board pattern, xenon flash, goggles. In this article, flashes of light are used as the stimuli because it will induce more amount of response as compared with other two stimuli. The subject is asked to see the xenon flash continuously till the end of the recording. The recording setup is shown in figure 3.

Likewise for all the 60 subjects VEP signal is taken and maintain the patient history in the excel sheet. So that it can be very useful for creating the MATLAB model for the classification.



Figure 3 Recording Setup

From the recorded values certain features like P100 latency, N145 latency, N75 latency and P100-N145 amplitude values are considered for the algorithm in the MATLAB.

SVM CLASSIFIER

In machine learning, Support Vector Machines (SVMs) are supervised learning models with associated learning algorithms that analyze and classify data used for regression analysis. Support Vector Machine constructs a hyperplane or set of hyperplanes with the help of feature vector in a high or infinite-dimensional space, which can be used for classification.

RESULTS AND DISCUSSION

The amplitude levels for the control group is about 5-10 micro volt and for the diabetic with retinopathy cases it is about 3-5.5 micro volt and for the diabetic with retinopathy cases it is about less than 3.5 micro volt. After creating the patient database in the excel sheet we want to create the classifier in the MATLAB for the data classification. Then run the program and select the folder path so that the result is displayed in the screen as shown in the figure 10. In the Table 1 and 2 shows P100, N145 and N75 latencies for Control group and Diabetic group respectively.

Age	<40 years	41-60 years	>60 years
	(mean ± SD)		
P100 latency	95.01 ± 4.88	98.98 ± 6.63	106.9 ± 5.87
N145 latency	140.09 ± 5.89	145.53 ± 4.99	150.7 ± 6.33
N75 Latency	65.31 ± 4.31	72.66 ± 4.55	75.34 ± 6.23

TABLE 1 Mean P100 Latency, N75 Latency, N145 Latency Differences n Control Group

Age	<40 years	41-60 years	>60 years
	(mean ± SD)		
P100 latency	104.56 ± 4.12	108.12 ± 5.66	114.95 ± 10.34
N145 latency	144.39 ± 6.73	149.87 ± 4.99	155.7 ± 6.33
N75 latency	74.27 ± 11.05	77.08 ± 8.02	80.34 ± 6.23

TABLE 2: Mean P100 Latency, N75 Latency, N145 Latency Differences in Diabetic Group

From the above tables, it is clearly shown that the latencies get delayed in the Diabetic group when compared to Control group cases. The latencies get varied with respect to age also in the case of above 60 years P100 is

106.9 ± 5.87, N145 is 150.7 ± 6.33 and N75 is 75.34 ± 6.23 in the case of control group .And for above 60 years P100 is 114.95 ± 10.34, N145 is 155.7 ± 6.33 and N75 is 80.34 ± 6.23 in the case of diabetic groups.

CONCLUSION

VEP measurements show the involvement of anterior visual pathways, before the development of Retinopathy. Visual evoked potentials are deranged and there was significant changes in latencies and amplitude in diabetes patients. This study compares VEP among 30 diabetics and equal number of healthy controls. It was observed that P100 latency was prolonged in diabetics patients compared to controls. These changes are responsible for the changes in latency of optic nerve responses. P100 latency in the retinopathic cases is about 120 or above and in non-retinopathic cases it is about 114. Since P100 prolongation in diabetes is a remarkable sign of Diabetic Retinopathy, VEP assessment must be done for all diabetic patients to identify their visual defects earlier. This article deals with classification between the Diabetic with and without retinopathy by using the classifier in the MATLAB. In future, there was an idea of real-time monitoring and thereby classifying the diabetic with/without retinopathy and also from VEP signal other eye dysfunctions can be found out.

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