

## Visual evoked potential changes in diabetes mellitus

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### Abstract

**Background:** Diabetes Mellitus (DM) a metabolic disorder is the most common cause of neuropathy. Electrophysiological studies are commonly employed to detect the neuropathy. The present study was undertaken to find out the utility of visual evoked potential (VEP) as an early indicator of central neuropathy in diabetic patients.

**Materials & methods:** The present study was carried out in 60 healthy subjects and 60 diagnosed DM patients of age group 20 to 40 years. Visual evoked potential (VEP) tests were recorded in sports physiology laboratory of Medical College on an outpatient basis, using RMS EMG.EP machine. It is to find out whether the VEP latencies are altered in diabetes or not.

**Result:** In our study there is statistically significant increase in latencies of P100 waves of both eyes in diabetic patients as compared to control subjects ( $p < 0.001$ ). The N75-P100 amplitude is decreased in diabetic patients as compared to control subject but it is not statistically significant ( $p > 0.05$ ).

**Conclusion:** The abnormalities in the VEP response occur in diabetic patients before the development of overt retinopathy. So, VEP measurements can be used for the early diagnosis of central neuropathy to offer an early opportunity for proper management.

**Keywords:** Diabetes Mellitus (DM), VEP, P100 wave, retinopathy

### 1. Introduction

DM is an endocrine disorder that is characterized by defect in insulin secretion &/or insulin action resulting in hyperglycaemia. Diabetic neuropathies (DN) are neuropathic disorders that are thought to result from diabetic microvascular injury involving small blood vessels that supply nerves (vasa nervosum) in addition to macrovascular conditions that can culminate in DN cause significant morbidity & mortality.

Electrical potentials that occur in the cortex after stimulation of a sense organ, which can be recorded by surface electrodes, are known as Evoked Potentials [EP]. E.g. Somatosensory Evoked Potential (SEP), Auditory Brainstem Response (ABR) and Visual Evoked Potential (VEP).

Previous studies have shown the peripheral nervous system involvement in diabetes mellitus. However, little is known about the central nervous system involvement in diabetes. Visual evoked potentials (VEPs) could be used to evaluate disturbances in the central visual pathways. [1]

VEPs are produced by electrical activity of the visual cortex in response to light or pattern stimulation of the eye. It can detect functional loss in the visual pathway from retina to the visual cortex. [2]

In diabetes mellitus, visual deficit appears to result from both vascular disease and metabolic abnormalities, which can affect the retina, optic nerve and visual pathways.

## 2. Materials and Methods

60 healthy subjects and 60 patients with diabetes mellitus of age group 20 to 40 years were enrolled in the study. All patients underwent fundoscopic examination before the VEP test. Exclusion criteria were diabetic retinopathy, glaucoma or opacification, or visual acuity <6/18 with corrective lenses.

Visual evoked potential test was conducted after taking a written and informed consent from the patients. The patients were explained the procedure in their own language and were put at ease.

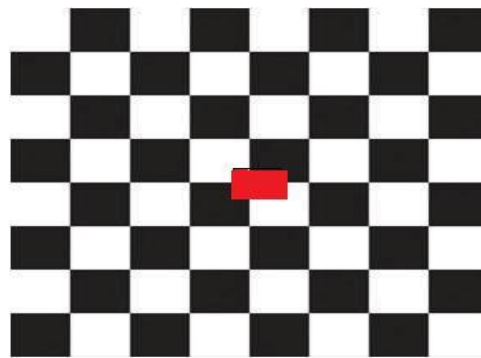
The subject was explained the entire test to ensure full cooperation. The usual glasses if any were allowed to put on during the test. The subject was instructed to avoid usage of miotic or mydriatic drugs 12 hours before the test.

Visual evoked potential (VEP) tests were recorded in sports physiology laboratory of Medical College on an outpatient basis, using RMS EMG.EP machine manufactured by Recorders & Medicare Systems (p) Ltd. VEP monitor which displayed checker board pattern consisting of black and white checks, was used to give the stimulus

The Preferred stimulus was the reversal of a black and white checkerboard pattern, as it tends to evoke larger and clearer response than other patterns. The square checks alternate from black/white to white/black at the rate of 1.71/sec. without change in over all luminance of screen. This was accomplished by displaying 8x8 checker board pattern on the computer screen using visual basic software.

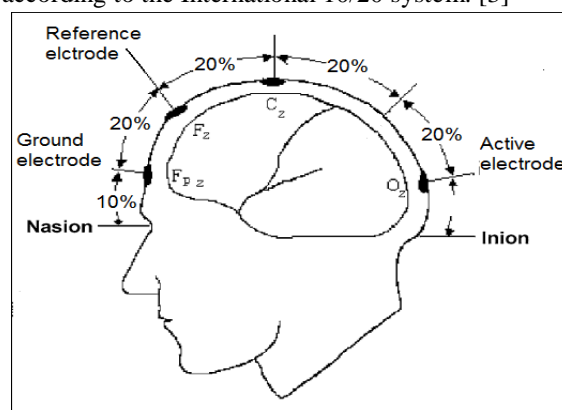
Unocular stimulation was given to both the eyes separately with black and white checks that change phase (i.e., black to white and white to black) abruptly and repeatedly at a specified number of reversals per second using a checkerboard.

The subject was asked to sit comfortably in front of the checkerboard pattern at an eye screen distance of 100cm. The subjects were instructed to gaze at red coloured dot in the centre of checkerboard pattern. Every time when there was alteration in the pattern, the subject's visual system generated an electrical response which was recorded using electrodes. [2]



**Fig 1: Showing 8x8 checker board pattern on the computer screen**

The surface electrodes were placed with electrode paste after cleaning the site with spirit swab. The surface electrodes were placed relative to bony landmarks, in proportion to the size of the head, according to the International 10/20 system. [3]

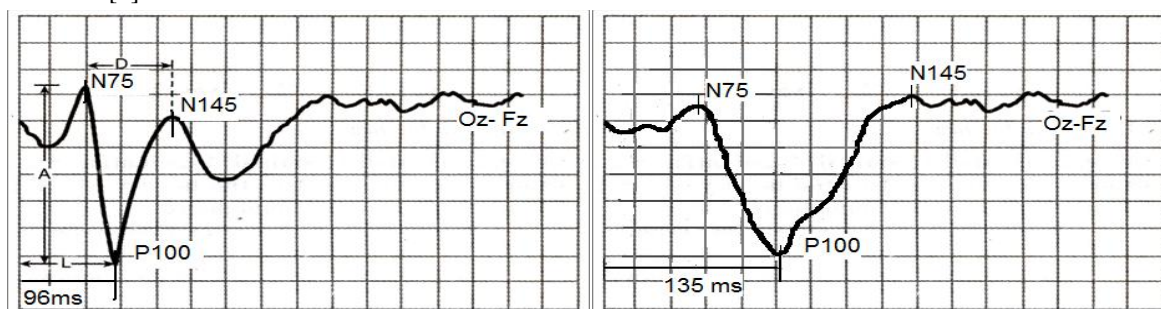


**Fig 2: Oz - active, Fz - reference electrode, Fpz - ground electrode**

The active electrode was placed on the scalp over the visual cortex at Oz with the reference electrode at Fz. A separate electrode should be attached to a relatively indifferent point and connected to the ground; commonly used ground electrode position is the forehead (Fpz). The subscript z indicates a midline position. Montage consisting of one channel was used for VEP recording (Channel 1 Oz- Fz).

The first major positive peak (P100) was measured after stimulation of each eye.

The results were expressed as means ± SD. Comparisons between groups were carried out with Z test.



**Fig 3: VEP in normal individual and in diabetic patients.**

### 3. Results

Result shows that there is statistically significant increase in latencies of P100 waves of both eyes in diabetic patients as compared to control

subjects ( $p < 0.001$ ). The N75-P100 amplitude is decreased in diabetic patients as compared to control subject but it is not statistically significant ( $p > 0.05$ ).

**Table no 1: Mean values of P100 wave of LEFT EYE in diabetic patients and controls.**

	Diabetic patients	Control	Z test	'p' value
P100 latency	118.54±10.01	100.75±4.36	Z=12.62	P<0.001*
P100 –N 145 Amplitude	6.24±3.12	5.61±2.17	Z=1.28	p> 0.05

(\* - statistically significant)

**Table no 2: Mean values of P100 wave of RIGHT EYE in diabetic patients and controls.**

	Diabetic patients	Control	Z test	'p' value
P100 latency	118.20±10.64	100.44±4.38	Z=11.95	P<0.001*
P100 –N 145 Amplitude	6.25±3.05	5.61±2.18	Z=1.32	p> 0.05

(\* - statistically significant)

### 4. Discussion

The P100 wave form is generated in the striate and peristriate occipital cortex due to the activation of the primary visual cortex and also due to the discharge of the thalamo-cortical fibers. [4] There is statistically significant increase in P100 latency of both eyes in diabetic patients as compared to healthy controls.

In our study, a delay in the P100 latencies in all the diabetic patients as compared to the controls was consistent with the observations of Varkonyi *et al* [5], Dolu *et al* [6], Azal *et al* [7], Szabela *et al* [8] and Li *et al* [9] who reported similar changes in their study.

The N75-P100 amplitude is decreased in diabetic patients as compared to healthy controls but it is not statistically significant ( $p > 0.05$ ). A certain reduction in N75-P100 amplitude of diabetic patients observed in this study, is in line with the observations of Azal *et al* (1998) [7], Li *et al* (2001) [9], Atilla *et al* (2006) [10], Karlica *et al* (2010) [11]

The exact pathophysiology of the central nervous dysfunction in diabetes mellitus is not clear, but it seems to be multifactorial, involving metabolic and vascular factors, which is similar to the pathogenesis of diabetic peripheral neuropathy. Delay of the latency to the major positive wave P100 in Visual Evoked Potential is a very sensitive method of detecting demyelination in the optic nerve. Demyelinated fibers cannot conduct trains of impulses at physiological frequency, resulting in a block. [12]

Excess glucose is shunted into the polyol pathway and is converted to sorbitol and fructose by the enzymes aldose reductase and sorbitol dehydrogenase respectively. The nerve cell membrane is relatively impermeable to sorbitol and fructose, which tend to accumulate within the nerve.

Fructose and sorbitol both being osmotically active compounds lead to increase in the water content in the nerves. It leads to a cascade of events like a reduced membrane  $\text{Na}^+$ -  $\text{K}^+$  ATPase activity, intra-axonal sodium accumulation which reduces nerve conduction velocity and brings about structural breakdown of the nerve. Vascular hypothesis (Ischemic/Hypoxic) stresses on the early development of reduced endoneurial blood flow, increased endoneurial vascular resistance and reduced endoneurial oxygen tension as causative of Diabetic neuropathy. [13]

### 5. Conclusion

From the present study, it can be concluded that the changes in the VEP response in diabetic patients occur much before the development of overt retinopathy and the prolongation of latencies in this study is thus may be an expression of the structural damage at the level of myelinated optic nerve fibers and are probably polyol pathway dependent or due to microvascular damage.

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