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Original Research Article

A Hospital Based Assessment of the Normative Data for VEP P100 Latencies and Amplitude in Normal Subjects

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Abstract

Aim: The aim of the present study was to assess the normative data for VEP P100 latencies and amplitude in normal subjects.

Methods: The study was conducted by the Department of Physiology, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, India. The study comprised of 50 healthy subjects within the age group 40-60 years, in which there were 25 males and 25 females.

Results: The mean latency of P100 wave in normal subjects was 97.63+5.65 milliseconds. The mean P100 amplitude was 7.43+1.145 μV.

Conclusion: We concluded that normative P100 waveform peak latencies and amplitudes will help evaluate and interpret VEP anomalies. The values depend on the equipment, recording technology, and lab conditions. The normative values of any neurophysiological laboratory conducting VEP research should aid clinical interpretation.

Keywords: Normative, Pattern reversal, Visual Evoked Potential, P100 wave, latency, amplitude

Introduction

Visual evoked potential (VEP) is an electrical waveform that is generated by the electrical activity in the visual cortex in response to a visual stimulus. This waveform is detected and recorded by electrodes placed on the scalp. The VEP is a neural route that carries visual information from the retina, optic nerves, and optic tracts to the occipital brain, where it is processed. Hence, it may assist in the diagnosis and prognosis assessment of certain neurological conditions, including multiple sclerosis, optic nerve glioma, traumatic optic neuropathy, and several other disorders that can affect the visual system. [1]

Subjective parameters such as age, gender, head circumference, and subject attentiveness, as well as technical elements like kinds of stimulus monitor, size of stimulus box, distance between stimulus point and subject's eye, and room illumination, have an impact on the latency and amplitude of VEP.1,2 A typical VEP response to a stimulus is characterised by a positive peak occurring at an average delay of 100 ms. Consequently, it is necessary for each laboratory to establish and provide its own normative values for VEP, which might serve as parameters. [1-4] Evoked potentials are noninvasive assessments that quantify the electrical reaction of the nervous system to various sensory stimuli, such as brainstem auditory evoked potentials (BAEP), visual evoked potentials (VEP), and short-latency somatosensory evoked potentials (SSEP). [5] Visual evoked potentials (VEP) are used to evaluate the integrity of the visual conduction pathways spanning from the optic nerves to the brain. VEP is measured by stimulating the visual fields, often using a checkerboard visual stimulus, and recording the evoked response using surface recording electrodes placed across the occipital lobe. It is important to do monocular stimulation while assessing the visual pathway to avoid overlooking a unilateral problem. However, there are exceptions to this rule, such as when dealing with neonates. [6] There are three established stimulus procedures for recording VEP7: (a) Pattern-reversal VEP, (b) Pattern onset/offset VEP, and (c) Flash VEP. The pattern reversal VEP is the stimulus of choice for most applications because to its consistent waveform and peak latency, which show little variation both within an individual and throughout the general population. [8] A typical VEP response to a pattern-reversal stimulus is a positive peak that appears at an average delay of 100 ms. The VEP waveform consists of three distinct phases: an early negative deflection known as N70, a significant positive deflection referred to as P100, and a subsequent negative deflection called N155. The delay at its highest point

and the difference in amplitude between the highest and lowest points of these waves are measured. [9]

The variability of visual evoked potentials (VEP) may be influenced by several physiological parameters, such as age, sex, visual acuity, and pupillary size. It may also be influenced by technical factors such as the size of the cheque, the brightness, and the size of the field. [10] The influence of gender on the amplitude and latency of pattern reversal VEP parameters has been acknowledged as a significant physiological element. Multiple prior investigations conducted across different age groups have consistently shown that females have greater P100 amplitudes and shorter P100 latencies. [11]

The objective of this research was to evaluate the standard data for VEP P100 latencies and amplitude in individuals aged 40-60 years who do not have any abnormalities.

Materials and Methods

The research was carried out by the Department of Physiology at Netaji Subhas Medical College and Hospital in Bihta, Patna, Bihar, India. The research included 50 individuals who were in good health and aged between 40 and 60 years. The group consisted of 25 men and 25 females. A comprehensive clinical examination was conducted on each participant after the acquisition of signed informed consent and a full clinical history.

The ocular examination included the assessment of visual acuity using Snellen's chart and near vision chart, evaluation of ocular movements, investigation of pupil responses, and screening of the confrontational visual field. The first assessment of the fundus was conducted using direct ophthalmoscopy.

Inclusion Criterion

Both male and female subjects with visual acuity 6/6 with normal pupillary reactions, normal fundus and full and normal field of vision.

Exclusion Criterion

Presence of any illness that could influence visual evoked potential, subjects with history of serious visual problems, any major chronic ophthalmic disease, traumatic optic nerve atrophy, multiple sclerosis, retrobulbar neuritis, glaucoma, ishaemic optic neuropathy history of major illness like diabetes, hypertension, HIV infection, hereditary and degenerative diseases, history of drug abuse and history of cerebrovascular accidents, recent eye medications with mydriatics and cyclopegics prior to the test were excluded from the study.

On the basis of detailed clinical examination, subjects were recruited for the study.

Patients were subjected to VEP test on RMS EMG EP MK-II machine in the Neurophysiology unit of Department of Physiology, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, India.

Visual Evoked Potential (VEP) Test -

Pretest evaluation - Participant preparation for PRVEP test

The subjects were advised to come without oil or any hair chemical to the scalp.

They were instructed to have an adequate sleep the previous night to prevent the effect of drowsiness on the responses.

Subjects were explained about the procedure in detail to ensure full co-operation and avoid apprehension

VEP instrumentation room set-up-

Equipment

VEP was recorded with a pc based, two channels, RMS EMG EP MK II machine -equipped with pattern- shift stimulator television screen, signal amplifier with filters, computer system for averaging.

VEP was performed in a specially equipped electro diagnostic procedure room, made dark and sound attenuated for the test. Subjects were seated comfortably about 100 cm away from a video monitor.

Electrodes and Electrode Placement

Standard surface electrodes were placed according to the international 10/20 system of electrode placement (ISCEV standards, 2009).6

This system specifies the position of scalp electrodes as percentage of distances between definitive landmarks such as nasion, inion and ear tragus (Figure 1). The placing of the electrodes as well as the nature of PVEP testing was explained to each participant.

The recording electrodes were placed on the scalp at the following reference points:

Oz (Occipital region) = Active or recording electrode Cz (Vertex) = Ground electrode

Fz (Frontal region or forehead) = Reference electrode

Head size measurements were taken from nasion to inion prior to the electrodes placement. To apply the electrodes, conductive electrode paste was applied on the marked electrode locations to make sure a good, stable electrical connection between the scalp and the electrodes was made. Each electrode was pressed firmly onto the scalp with the help of contact paste. Micropore gauze was placed on top of the

electrodes to ensure their contact was maintained. The electrode impedance was kept below 5 kΩ.

VEP Recording

A montage consisting of one channel (Oz-Fz) was used for VEP recording. The video- monitor presented a black and white checkerboard pattern with a fixation spot in the centre of the screen (mean luminance 50 candela/ m2 and contrast 70%). At the viewing distance of 100 cm, the check edges subtend a visual angle of 15 minutes with video monitor screen subtending an angle of 12.5°. The checks / pattern elements reversed alternately at a rate of twice per second. The bioelectric signal was amplied (gain 20,000), filltered (band-pass, 1-100 Hz), and 150 events free from artifacts were averaged for every trial. Every time the pattern alternates, the subject's visual system generates an electrical response that was detected and recorded by surface electrodes, which were placed on the scalp overlying the occipital and parietal regions with reference electrodes on the midline of frontal region (Fz). Subjects were instructed to fix the gaze on a small red coloured block at the centre of the screen of video monitor (Figure 2). Monocular stimulation was done with an eye- patch covering the other eye.

PRVEP instructions given to participants

The participants were requested to remain comfortable and relax when viewing the checkerboard screen. They were instructed to maintain a normal blink rate to ensure a clear optical image. Also, if the subject experienced any discomfort he or she was asked to mention it. The participants were instructed to maintain their focus on the central red coloured block in the centre of the display screen.

PVEP waveform and markings --PVEP recording parameters

With the preset stimulus and recording conditions as mentioned above and keeping the electrode impedence <5 kΩ, the recording procedure was started. To verify the reproducibility of the waveform, two responses were recorded and superimposed. Trials were repeated if there was inconsistency of the response.The PVEP waveform thus obtained was used for measurements.

The waveforms were labeled for the peaks N75, P100 and N145. The latency of the response was measured from the sweep onset that corresponded to the presentation of the stimulation. The first major positive peak (P100) was measured after stimulation of each eye. The parameters taken for the study were P100 latency of the waveform measured in milliseconds (ms), and N75-P100 amplitude which is measured from the peak of N75 to the trough of P100 (N75-P100), in microvolts (μV) in both eyes.

Statistical Analysis:

The mean and standard deviation for latencies and amplitudes of VEP waves was obtained. The values were taken as VEP electrophysiological data (normal values), for our laboratory, in persons in this region.

Results

Table 1: Normative values of PRVEP P100 latency and amplitude

Parameter	Mean	Standard Deviation
P100 latency (ms)	97.63	5.65
N75-P100 Amplitude (μV)	7.43	1.15

The mean latency of P100 wave in normal subjects was 97.63+5.65 milliseconds. The mean P100 amplitude was 7.43+1.145 μV.

Discussion

VEP is an important procedure for evaluating visual function and is highly sensitive to lesions of the optic nerve and anterior chiasm.[6] The activation of visual cortex primarily occurs by the central visual field. VEP may be affected if there is abnormality anywhere along the visual pathway including the eye, retina, the optic nerve, optic radiations, and occipital cortex. [7]

Electrical potentials that occur in the cortex after stimulation of sense organ, which can be recorded by surface electrodes, are known as Evoked Potentials, e.g. Somatosensory Evoked Potential (SEP), Auditory brainstem response (ABR) and Visual Evoked Potential (VEP). 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. [12] The visual evoked potentials is an important diagnostic tool used by neurophysiologist, ophthalmologist, neurologists and neurosurgeons as many neurological disorders present with visual abnormalities, when the clinical signs and the results of neuroimaging methods are either non informative or non-conclusive. [13] The mean latency of P100 wave in normal subjects was 97. 63+5.65 milliseconds. The mean P100 amplitude was 7.43+1.145 μV.

Normal VEP: The usual waveform is the initial negative peak (N1 or N75) followed by a large positive peak (P1 or P100) and followed by another negative peak (N2 or N135). Of these, P100 is said

to have the origin in the visual cortex. Clinical interpretation of PVEP is largely based on latency and amplitude of major positive peak P100. It derives its name from the fact that it occurs approximately 100 msec after the stimulus onset and is most consistent , least variable peak and reproducible waveform as compared with N75 and N 135 waves which is generated in striate and parastriate visual cortex in response to visual stimulus. It thus measures the velocity of nerve conduction and synaptic transmission. [14,15] Reductions in the number of receptors, axons in the optic nerve, etc reduce the amplitude of the response while slowing of the conduction in the visual pathway produces prolongation of the latencies. [15] The value reported by Shahrokhi et al [16] (1978) for P100 latency was 102.3+5.1. and 10.1+4.2 for P100 amplitude. In an Indian study conducted by OP Tandon [17], the value reported for P100 latency was 94.25+ 7.14 and 6.53+ 2.44 for P100 amplitude.

Conclusion

In conclusion, we provided normative P100 waveform peak latencies and amplitudes to evaluate and interpret VEP anomalies. Machine, recording technical aspects, and lab environment impact values. Neurophysiological laboratories doing VEP tests should have their own normative values to aid clinical interpretation.

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