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Visual Evoked Potentials (VEPs): Mechanism, Uses, and Benefits behind this vital IONM Modality.

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Cesia M. Alvarez [1,2]
Faisal R. Jahangiri [1,2,3]

[1]Global Innervation LLC, Dallas, Texas, USA.
[2]Department of Neuroscience, School of Behavioral & Brain Sciences, The University of Texas at Dallas, Richardson, Texas, USA.
[3]Labouré College of Healthcare, Milton, Massachusetts, USA.

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INTRODUCTION

Visual evoked potentials or VEPs are a type of neuromonitoring modality specifically used for evoking and recording neural signals in the visual/optic pathway – more specifically, for detecting injuries surrounding the optic nerve and pre-chiasmatic areas. Visual Evoked Potentials (VEP), also known as Visual Evoked Response (VER), is a type of electrophysiological testing to measure the electrical potential resulting from a visual stimulus. VEP neuromonitoring is prescribed for individuals suffering from different visual pathologies such as multiple sclerosis, loss of vision, abnormalities in color vision, blurred or/and double vision, etc. There are two types of VEPs – pattern VEPs (PVEP) and flash VEPs (FVEP). Pattern VEPs is when the clinician asks the patient to watch a checkered pattern on a screen while recording optic neural signals from the brain. On the other hand, flash VEPs are almost the same type of test but with light-omitting goggles instead of presenting a visual pattern. Light-omitting goggles are placed on the eyes bilaterally, and responses are recorded from visual pathways, including the cornea, optic chiasm, and the occipital lobe (visual cortex). Both tests take no longer than an hour in duration in outpatient clinics. Some factors could influence the VEP responses, such as age, gender, or any medication taken before doing the test that could produce drowsiness in the patient thus, it is important to follow any instructions coming from the professional in charge of the neuromonitoring assessment.

VEPs can be done intraoperatively by placing special goggles, which elicit a flashing red light stimulus, thus evoking a visual response in the visual cortex, which is analyzed during the surgical procedure. Additionally, this neuromonitoring modality can be used outside the operating room as a simple eye exam (non-invasively) by placing electrodes in the head of the

patient and instructing the patient to carefully watch a presentation of different visual patterns on a checkerboard screen. As the patient watches and follows the instructions from the medical professional, visual potentials are simultaneously recorded and will be later analyzed and used for diagnosis. The VEPs measures the time it takes for an evoked visual signal to travel from the eye along the optic nerve to its ultimate destination, the occipital lobe at the back of the brain. Any abnormalities in the recorded signals along the neural optic pathway could indicate pathology. Thus, it should be further analyzed by the clinician.

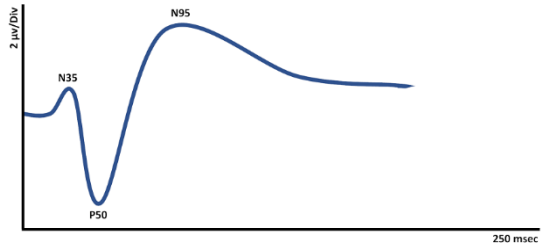

Figure 1: Schematic diagram of a biphasic Electroretinogram (ERG) waveform. A cornea-negative a-wave (N35) is followed by a cornea-positive b-wave (P50) (Jahangiri et al. 2020).

There is a risk of postoperative visual deficit when resecting lesions near the optic nerve. The major concern is the loss of vision. A multimodality Intraoperative Neurophysiological Monitoring (IONM) with Electroretinography (ERG) and Visual Evoked Potentials (VEP) is a well-recognized method to identify any injuries to the optic nerve during the tumor resection. IONM provides real-time feedback to the surgeon during the resection. This immediate feedback decreases the risk of neurological injury.

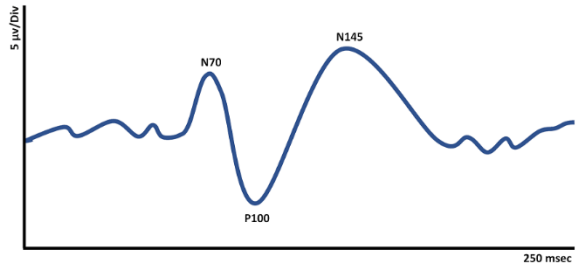

Figure 2. Schematic diagram of Visual Evoked Potentials (VEP) to flash stimulation showing the occipital responses N75, P100, and N145. The amplitude of the responses is maximal at the MO electrode recordings and lower amplitude responses at the LO and RO recording channels. A bandpass filter of 1-250 Hz (Jahangiri et al. 2020).

Visual evoked potentials represent a vital neuromonitoring modality since it is very sensitive to any changes in neural potentials. Thus, it has a tremendous preventive and diagnostic value that aids clinicians in detecting and treating different optic nerve pathologies and/or injuries. Glaucoma, ocular hypertension, optic neuropathies, optic lesions, multiple sclerosis, etc., are some examples of illnesses that can be easily detected by VEPs. Furthermore, other modalities are used along VEPs for the detection and analysis of optic neural pathway pathologies, such as nerve action potentials (NAP) and electroretinogram (ERG), which offer a range of more selective readings coming from more specific eye areas.

Visual evoked potentials (VEP) can be used effectively to prevent vision loss during surgery and direct the surgeon intraoperatively. Brain injuries, optic neuritis, neuropathy, tumors compressing the optic nerve, and retrobulbar neuritis surgery can all cause abnormal VEPs. Visual loss after brain surgery is a

devastating complication. Continuous monitoring of visual function is desirable during surgeries that put the visual pathway at risk of injury. However, intraoperative monitoring of the visual evoked potential (VEP) is still uncommon.

ORCID

Cesia M. Alvarez https://orcid.org/0009-0003-9575-0794

Faisal R. Jahangiri https://orcid.org/0000-0002-1342-1977

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