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Casting a Cursory Glance at the Evoked Potentials on the Retina: A Panoptic Diagnostic of the Clinical Macrocosm

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ABSTRACT

Visual sense is one of the primitive senses that has been developed evolutionarily. After all, it allows us to perceive the beauty present in our environment and allows us to interact with others. VER (visual evoked response) is the only clinically objective technique available to assess the functional state of the visual system beyond the retinal ganglion cells. Hence it can be used as a panoptic diagnostic tool in the clinical world. This article unravels the relationship between Visual evoked potentials and age, smoking, alcoholism, schizophrenia, refractive errors and glaucoma.

Keywords: Visual Evoked Potentials, smoking, alcoholism, schizophrenia, refractive errors, glaucoma.

INTRODUCTION

Visual sense is one of the primitive senses that has been developed evolutionarily. After all, it allows us to perceive the beauty present in our environment and allows us to interact with others. The visual pathway is a trail which carries information from the receptor's rods and cones on the two retinas, to the sensory homunculus.[1]

The visual nerve signals arise in the rods and cones (end organs), from which they are transmitted to the bipolar cells that convey the sensation to the ganglion cells after which they leave the retinas through the optic nerves. Each optic nerve carries about 1 million fibres from each retina. At the optic chiasm, the optic nerve fibres from the nasal halves of the retinas decussate, where they join the fibres from the opposite temporal retinas to form the optic tracts. The fibres of each optic tract then synapse in the dorsal lateral geniculate nucleus of the thalamus, and from there, geniculocalcarine fibres pass by way of the optic radiation (also called the geniculocalcarine tract) to the primary visual cortex in the calcarine fissure area of the medial occipital lobe. The visual pathway is one of the only 2 pathways that are visual pathway and olfactory pathway which do not go through brain stem. [2-3]

Visual pathway carries visual information which have great impact on how we react to the surroundings and how we perceive other stimuli. Consequently, it becomes very crucial to asses this pathway. To do so we use numerous advancing neurological tools. One of which being Visual evoked potential (VEP), which is nothing but the EEG (electroencephalogram) recorded at the occipital lobe. VER (visual evoked response) is the only clinically objective technique available to assess the functional

state of the visual system beyond the retinal ganglion cells.

An EEG (introduced by the German psychiatrist Hans Berger) is a recording of the neuronal electrical activity of the cerebral cortex made by electrodes placed on the skull/scalp. EEG waves normally reflect the summed extracellular currents that result from the generation of synaptic potentials in the pyramidal cells, the EEG waves reflect the combined activity of many pyramidal cells. [4]

Evoked potential refers to surface electrical activity recorded from the surface of the scalp in response to a specific, collective and adequate stimulus. It is of two types depending upon the techniques used:

1. Flash VER-It is recorded by using an intense flash stimulation. It merely indicates that light has been perceived by the visual cortex. It is not much affected by the opacities in the lens and cornea.
2. Pattern reversal VER-It is recorded using some patterned stimulus, as in the checker board. In this the pattern of the stimulus is changed (e.g., black squares go white and white become black) but the overall illumination remains same. The pattern reversal VER give a rough estimate of the visual acuity. [5]

VEPs initiated by strobe flash were observed in the early years of EEG in the 1930s.[6]

Du Bois-Reymond et al. demonstrated normal electric potentials recorded from the surface of a muscle on contraction. Berger et al. named spontaneous ongoing activity of the brain as "Das Elektrenkephalogram" and in 1940 launched the electroencephalogram as clinical neurologic test which is now used worldwide.[7]

METHODOLOGY FOR CHOOSING ARTICLES FOR THE REVIEW:

Peer reviewed articles published between 1990 and 2022 present on Google Scholar with the keywords: Visual Evoked Potentials, smoking, alcoholism, schizophrenia, refractive errors, glaucoma. The beginning date (i.e., 1990) was chosen because that was the time from when Visual evoked potentials were started being widely used in the sophisticated cosmos.

THESIS STATEMENT:

The objective of the literature review is to explore the widespread usage of Visual Evoked Potentials in diagnosing and accessing different disorders related to the vital organ systems of the body. Age, smoking and alcoholism, Schizophrenia refractive errors, were some of the factors majorly being considered for the article.

VEP AND AGEING:

VEP outcomes depends on the age of the subject not only in terms of outcomes but reading techniques and parameters. By the age of 3 years, children usually cooperate fully, allowing the use of same recording parameters as adults. The problem for children less than 3 years of age is maintaining fixation. VEPs change rapidly in form and complexity in the first 6 months.

In a normal infant 20/20 (6/6) vision is present by about 9 months of age. As the infant matures, the P1 appears earlier and earlier, so that by about age 5 years, peak time shortens to near 100ms using pattern reversal stimuli, and about 110ms using flash stimuli. Peak times remain near this point through adulthood with no statistically significant change until after age 55 years. The amplitude of the mature P1 component of flash and pattern VEPs is greatest at about age 7–8 years. The brain reaches 90% of adult size as early as 6 years. Preadolescence is the period when the brain is largest relative to skull, scalp, and muscle thickness. As children enter adolescence and maturity, these tissues thicken, attenuating the brain's signal recorded from the overlying scalp. The amplitude and speed of VEPs remains stable until about age 28 years, at which time amplitudes begin to attenuate. [8-9]

EFFECT OF REFRACTIVE ERRORS (RE) ON VEP READINGS:

It is known that the technical and physiological factors such as pupil diameter, refractive errors, type of stimulus, age and sex, electrode position and anatomical variations may affect VEP. It is assumed that RE cause defocus.

The amplitude of the response in a pattern reversal VEP is dependent on the visual system's ability to resolve the pattern and on the degree of retinal image focus. Small errors of refraction tend to reduce the average amplitude of the waves of VEPs. A quantified documentation was provided by Millodot M. et al. who found the VEP amplitude to be decreased 25% per diopter of defocus and the effect was appreciable for 0.25 D. [10] They employed a rotating polaroid in conjunction with a checker pattern made of polaroid strips, in which the intensity for each neighboring check varied sinusoidally in time. The VEP is more sensitive to small refractive changes than electroretinogram, perhaps because the VEP heavily emphasizes the foveal region while the ERG is more broadly representative of the entire stimulus field.

Collins *et al*. Studied the effect of introduced REs on the VEP on five women and eight men aged 19-45 years.[11] There was a pronounced effect on the P100 component of the VEP with these introduced REs.

Marr *et al*. [12] reviewed 114 consecutive children under 10 years of age with high hypermetropia (greater than + 5.00 DS) during a 5-year period and reported that high hyperopia has a similar incidence of associated ocular abnormalities as high myopia.

EFFECT OF SMOKING AND ALCOHOLISM ON VEP READINGS: [13]

It's a widespread understanding that smoking and alcohol has an adverse effect on the cardiovascular system and the central nervous system. They also have damaging effects on visual cortex. Not many neurophysiological measures can detect neuronal dysfunction, VEP is one of those used to understand the effects of tobacco smoking and alcohol on the visual cortex. Both tobacco smoking and alcohol consumption disrupts the functioning of Visual cortex in striking similar ways both giving an abnormal VEP reading in most of the cases. The abnormal VEPs recorded in both cases chiefly manifested predominant P100 latency delays with some of these accompanied by significant amplitude reduction. Cigarette smoking is one of the major causes of cerebrovascular and cardiovascular complications in both developed and developing countries. Smoking increases the risk of macular degeneration, cataracts, and poor eyesight.

Many common ophthalmological disorders such as retinal vein occlusion, age-related macular degeneration, cataract, anterior ischemic optic neuropathy, thyroid ophthalmopathy, and primary open angle glaucoma have been found to be associated with smoking. Diminished retinal sensitivity and peripheral scotomas in the visual fields have been observed in healthy heavy smokers. The previous data from different studies [14-25] showed robust pointers for usefulness of VEPs in relation to alcohol use disorder(s) not only in *in vivo* animal experimentations but also in humans helping to differentiate subgroup of patients who had been abstinent for more than 3 months to those who are either intoxicated or having withdrawal.

VEP AND SCHIZOPHRENIA:

Schizophrenia is an abnormality that affects person's neurological abilities like the ability to think and feel. It is characterised by thoughts and experiences out of touch from reality. VEP being an objective, non-invasive, simple, low cost technique used to evaluate the functional integrity of visual stimulus.[26-27] Considerable number of studies conclude the observation of abnormal VEPs in case of schizophrenia can be used as one of the early markers of the disorder, hypothesised in the form of

variations in topographical form of P100 component of VEP. VEP in schizophrenic patients demonstrate abnormal wavefront in many chronic and severe cases. PRVEP waveform abnormalities in schizophrenic patients have been previously ascribed [28-30] to defects within dorsal visual stream structures on the basis of its topographic distribution, estimated sources, and relative sensitivity to luminance contrast. This notion is in solid agreement with studies [31-34] demonstrating inadequacies in visuospatial functions in such patients. [35]

CONCLUSION

VEPs have of late been very useful in diagnosis and prognosis of different other disorder(s) as well. Kothari R et.al has extensively studied the changes in VEP patterns in various diseases like Diabetes mellitus – Type 2, [36] Primary open angle Glaucoma, [37] Carotid cavernous fistula,[38] Prognosis of post operative Pituitary macro adenoma, [39] to name a few.

Hence one can infer that Visual responses only play an important role in the visual acuity but also has relatability with may other clinical factors.

Declaration by Authors

Ethical Approval: Not Applicable

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