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Effect Of Different Check Sizes And Fixation Sizes On Pattern Reversal Visual Evoked Potential In Normal Individuals.

[1]Anju Kumari Mahato, [2]Vikram Thakur, [3]Kamal Thakur, [4]Rahul Roy, [5]Sharath NS, [6]Dr Savitha Arun,
[1]M.OPTOM Student, [2]B.OPTOM, [3]Lecturer, [4]Asst Prof, [5]Lecturer, [6]Professor
[1]Department of Optometry,
[1]Nethradhama School of Optometry, Rajiv Gandhi University of Health Sciences, Bangalore, INDIA

Abstract :
Objectives: The purpose of our study was to evaluate the changes in latency and amplitude in terms of P100 with different check sizes and fixation sizes on PR-VEP in normal individuals.
Methods: The total sample size of our project was 30 individuals. A complete history of the volunteering patient was recorded. Each subject underwent a complete ophthalmic examination as a preliminary measure to exclude any ocular pathology. Visual evoked potential and its parameters (N80 Latency, P100 Latency and P100 Amplitude) for different checkerboard sizes and fixation sizes were recorded using a pattern reversal checkerboard with subjects seated comfortably at a distance of 72cm.
Results: There was a significant difference in latency and amplitude with a different checkerboard pattern. The latency was maximum for 4 x 4 squares and minimum for 13 x 13 squares. The amplitude difference was maximum for 13 x 13 squares and minimum for 4 x 4 squares.
Conclusion: Check size significantly affects the latency and amplitude of the 100ms and/or P100, but not the receptive areas for the stimulation. There was no change in latency and amplitude with different fixation sizes.
***IndexTerms* - Visual evoked potential, Pattern reversal, P100 latency, P100 amplitude, N80 latency**

I. INTRODUCTION

The visual evoked potential (VEP) is a cortical response that is time-locked to a visual stimulus event, such as the contrast-reversal of a checkerboard pattern or a flashlight. It is recorded using surface electrodes and differential amplifiers, both of which are commonly used to record the electroencephalogram (EEG). [1] Although the VEP is a cortically generated response, careful choice of stimulus can localize visual dysfunction. Monocular stimulation allows the localisation of dysfunction to the prechaiasmal visual pathway. Hemi -field stimulation and the use of multiple recording sites over the posterior head regions allow the detection of chiasmal and postchiasmal dysfunction in the visual pathways. Pattern stimuli are usually generated in a video monitor. The field size, pattern size, contrast, retinal location and rate of presentation of pattern stimuli can be varied. [2] Checkerboards are used most commonly in clinical settings because they generate the most robust VEP. [3] Checkerboard size helps to explore the function of the striate cortex (area 17) because local spatial frequency analyzers are presumably present there. Since some of the primary functions of the human visual system is to analyze contours and edges, the use of patterned stimuli seems to have an advantage in providing more information in this regard. [4, 5] Absolute latency is more reliable than absolute amplitude. A normal subject shows a latency variability of 2%-5% within and between recording sessions, whereas amplitude can vary by as much as 25% within and between subjects. Latency is clinically useful because an individual patient's latency can be compared to age-matched norms using statistical probability rules. Relative amplitude is reliable when comparing interocular differences. [3] The highest visual acuity area within the neurosensory retina is fovea centralis or fovea (radius 1.25mm), a central depression composed of closely packed cones and contains a very high concentration of cones. The fovea is responsible for the central vision which subtends 5° of visual angle, which is a central part of the macula. [6] Perifoveal is a part of the macula that circularly covers the fovea (2.75 radii from the fovea centralis). [7] The perifovea is a belt that covers a 10° radius around the fovea and is 1.5 mm wide. [8] The perifoveal ends when the

Henle's fibre layer disappears and the ganglion cells are one-layered that part of an image focused on the region of the retina surrounding the fovea. This region contains a mixture of cones and rods and does not provide as high a resolution as the fovea (also called mesopic vision) and it subtends 8° of the visual field. [5,10] Visual evoked potential can be affected by any abnormalities which can affect the visual pathway or cortex and Visual evoked potential can be affected by a variety of physiological factors including age, sex, visual acuity, check size, luminance field size, etc. Therefore, the present study was performed to evaluate the effect of changing the checkerboard size and fixation size on the latencies and amplitude of PR-VEP in normal individuals. [11]

II. MATERIALS AND METHODS

The study was conducted at Nethradhama School of Optometry, in association with Nethradhama Super speciality Eye Hospital. A total of 30 subjects were enrolled in the study. Informed consent was obtained prior to the conduct of the study. All the subjects underwent full ophthalmic examination. The subjects enrolled in this study accomplished the following inclusion criteria: subjects with distance visual acuity of 0.00logunit and near visual acuity of N6, co-operative subjects with normal fundus, age group considered (18-30 years), emmetropes with the spherical equivalent of ±0.25D to ±0.50D. Subjects with any ocular pathology, presence of manifest squint, colour vision abnormalities, amblyopia, small pupil size, any history of neuromuscular disorder and other diseases that might affect the visual acuity were excluded. Each subject was informed about the study purpose and procedure, and written consent was obtained. All the subjects enrolled were instructed one day prior as avoiding hair spray, gel or oil and not to use any type of eye drops (miotic or mydriatic drops) 12 hours before the test. The visual evoked potential was recorded using a pattern reversal checkerboard method with subjects seated comfortably at a distance of 72cm away from the screen of the visual evoked potential monitor. They were exposed to full-field monocular stimulation for the random eyes. The recording was done in a quiet dark room with a constant temperature. The signals recorded were filtered through a band spread of 2-100Hz. Responses to 200 stimuli were averaged for each eye. An average of three trials with well-defined pattern reversal visual evoked potentials was obtained for P100, N80 Latency and P100 Amplitude.

III. STATISTICAL ANALYSIS

All the statistical analysis were carried out with SPSS PC software version 25.O. Test for normality for our sample was performed using the Shapiro-Wilk test as our sample size was less than 50. For comparison related samples between groups, we have used repeated measure ANOVA for samples which were normally distributed and non-parametric Friedman test for samples which were not normally distributed. Post-HOC analysis was done by using Bonferroni adjustment..

IV. RESULTS

A total of thirty subjects were investigated for full field pattern reversal visual evoked potential with a different checkerboard pattern and keeping a constant checkerboard pattern with variable fixation size as a visual stimulus. The mean age group of the study was 20.77±0.71 years.

Table 1 shows, Maximum P100 latency of 102.23±4.25 ms was observed with a check size of 4x4 and the minimum P100 latency of 95.71±4.23 ms was observed with a check of 13x13. The latency difference was maximum for 4x4 squares and minimum for 13x13. We found statistically significant changes in P100 wave latency with different check sizes (p-value 0.001*). Post hoc analysis showed revealed a statistically significant decrease in P100 wave latency as check size was decreased (p value <0.001*).

A maximum P100 amplitude of 13.69±4.23 µV was observed with the check size of 13x13 and the minimum P100 amplitude of 10.57±3.33 µV was observed with the check size of 4x4. The amplitude difference was maximum for 13x13 squares and minimum for 4x4 squares. We found statistically significant changes in P100 amplitude with different check sizes (p value = 0.002*). Post hoc analysis showed revealed statistically significant increase in P100 wave amplitude decreased as check size was decreased (p value <0.001*). Mean LP80 for 4x4 was 70.91±1.43 ms, 8x8 was 70.88±2.23ms and 13x13 was 70.43±0.55ms. There was no statistically significant changes in P80 wave latency with different check sizes (p-value = 0.303).

Table 2 shows that N80 latency, P100 latency and P100 amplitude did not show any statistically significant changes when fixation size was altered (p-value >0.05).

Table 1: Effect of check size on P100 latency, P100 amplitude and N80 latency (Mean±SD)				
Check size	4x4	8x8	13x13	P value
LP100 (ms)	102.23±4.25	98.71±4.00	95.71±4.23	0.001*
AP100 (µV)	10.57±3.33	11.96±3.93	13.69±4.23	0.002*
LP80 (ms)	70.91±1.43	70.88±2.23	70.43±0.55	0.303
LP100 (ms): P100 wave latency in milliseconds, AP100 (µV): P100 wave amplitude in microvolts, LP80 (ms): N80 wave latency in milliseconds				

Table 2: Effect of fixation size on P100 latency, P100 amplitude and N80 latency (Mean±SD)				
Fixation size	At 1	At 25	At 50	P values
LP80 (ms)	71.72±3.79	70.88±2.20	70.53±0.98	0.282
LP100 (ms)	97.84±3.93	98.71±3.94	99.50±4.04	0.972
AP100 (µV)	11.11±3.32	11.94±3.93	12.63±3.42	0.376
LP100 (ms): P100 wave latency in milliseconds, AP100 (µV): P100 wave amplitude in microvolts, LP80 (ms): N80 wave latency in milliseconds				

V. DISCUSSION

VEP is a very important non-invasive and highly objective tool in detecting abnormalities in the visual system. It is useful not only for clinical neurophysiologists or ophthalmologists but also neurologists and neurosurgeons since many neurological disorders present with visual abnormalities. They may detect those abnormalities of the optic nerve which are poorly visualized by MRI and reflect subclinical involvement of the CNS even before the disease clinically manifests. Checks of 8x8 are most commonly used in neurophysiological laboratories so it was kept as a reference for the evaluation of the effects on VEP parameters. [4,5,12, 13] The visual system process information along multiple parallel channels. The optic tract starts from the optic chiasm and terminates in the lateral geniculate body. Two major pathways process visual information. The magnocellular pathway contains information about large and fast things i.e., low spatial frequency (large checks) which indicates there is an increase in latency and a decrease in the amplitude. And similarly Parvocellular carries information about small, slow things i.e., high spatial frequency and low temporal frequency which indicates the decrease in latency and an increase in amplitude.[4,5] In our study, the mean latency (in milliseconds) and mean amplitude (in microvolt) of P100 wave in normal subjects for 4x4 check size was 102.0 ± 4.25 ms and 10.57 ± 3.33 µV. The mean latency and amplitude of P100 wave for 8x8 check size were 98.71±4.00 ms and 11.94±3.93 µV respectively. Similarly, for 13x13 the latency and amplitude for P100 wave were 95.71±4.23 ms and 13.69±4.23 µV. The differences between the groups were statistically significant. Other studies have shown that deliberate alterations of the VEP can be minimized by using large checks, and binocular stimulation. Unfortunately, these conditions are not optimal for visual acuity testing, because the highest correlation of visual acuity and pattern VEPs is found with small check size and when small field size are used. Small checkerboard stimuli can be resolved only by the central visual field. P100 peak latency shortens for all check sizes, more rapidly for large check size than for small check size. The latency of pattern VEP provides a sensitive means of detecting subclinical demyelinating lesions of the visual pathways in adults and monitoring developmental changes in infants. The amplitude of pattern VEP is usually of greater interest in children than latency because it correlates well with visual acuity, particularly for small check sizes.[3] In a previous Indian study effect of check size on VEP in normal subjects, Ramji Singh and Ruchi Kothari reported mean peak latency for the check size for 4x4 of 99.24 ± 5.6 ms and P100 amplitude of 6.71±2.7 µV. For 8x8 the mean P100 latency was 97.3±4.39 ms and the mean P100 amplitude of 8.62±3.1 µV, similarly for 13x13 the mean P100 latency of 99.7±6.84 ms and the mean P100 amplitude of 9.15±3.12 µV. [4] Our results showed that the latencies of P100 waves were significantly longer in larger check sizes (4x4) as compared to that of smaller check size (13x13). Similarly, the amplitude of P100 wave was delayed in a smaller check size when compared to a larger check size. Our results were in agreement with the results of previous studies which showed shorter latencies and higher amplitude in smaller check size and delayed latency and shorter amplitude with larger check size. In the present study, we compared a constant 8x8 checkerboard size with a variable fixation size at 1, 25 and 50 and found that there was not much difference in the pattern reversal VEP parameters in N80 latency, P100 latency and P100 amplitude.

VI. CONCLUSION

Check size significantly affects the latency and amplitude of the 100ms and/or P100, but not the receptive areas for the stimulation. An appropriate and optimal check size can be used to minimize the following effects, which we in our study have taken 8x8. The VEP obtained with pattern stimulation; pattern reversal is dominated by contributions from the macula because the central few degrees of vision have a large representation in the striate area and are located posteriorly in the occipital lobe, closer to the surface electrodes. And there was no change in latency and amplitude with different fixation sizes.

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