Research Article

Visual evoked Potential (VEP): Physiological variation in normal children and adolescent up to 20 years of age

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Abstract

Introduction: Visual evoked Potential is the electrical potential difference recorded from the surface of scalp in response to Visual stimuli. It represents a resultant response of cortical as well as subcortical areas to photostimulation. Although various studies have been done on visual evoked potential but there are few studies from India only. Therefore this study was planned to study visual evoked potentials by recording battery of N70, P100 & N155 waveform in different age groups of normal healthy children. **Methods:** Present study was conducted in department of Physiology of Tertiary care teaching hospital. 50 healthy patients were included in two groups, below 5 years and 6- 20 years. Visual evoked Potential has been recorded and their physiological Variation has been observed. **Results:** It was seen that mean value and standard deviation of amplitude of N70 wave in left eye showed significant decrease in age group of 4 to 5 years. Mean value and standard deviation of amplitude of P 100 wave in right eye showed significant decrease in age group of 4 to 5 years. Other values were not significant. **Conclusion:** Age and sex have little impact on Visual evoked Potential in children. Eye dominance has been observed more commonly.

Key words: Visual evoked Potential, N_{70} latency in children, P_{100} amplitude in children.

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Introduction

The record of electrical events that occurs in cerebral cortex after stimulation of a sense organ is called evoked potentials (EPs) [1]. Evoked Potential test help to diagnose nervous system abnormalities, hearing loss & assess neurological functions [2]. These are useful as an index of cognitive functions in both health & disease [3]. Major type of evoked potential tests are 1. Visual evoked potential (VEP), 2. Brainstem auditory evoked Potential (BAEP), 3. Somatosensory evoked Potential (SSEP).

Visual evoked Potential is the electrical potential difference recorded from the surface of scalp in response to Visual stimuli. It represents a resultant response of cortical as well as subcortical areas to photostimulation [4]. It was first observed by Adrian and Mathews that fleshing light can induce a stimulus dependent change of brain activity [5].

VEP is primarily a reflection of activity originating in the central 3° to 6 ° of visual field, which is relayed to the surface of occipital lobe. The transient VEPs consist of series of waveforms of opposite polarity, the negative waveform is denoted as N and positive waveform is denoted as P, which is followed by the approximate latency in millisec [6]. The commonly use waveform are $N_{70,}$ P_{100} and $N_{155.}$ The P_{100} waveform of VEP is generated in occipital cortex due to activation of primary visual cortex and also due to thalamocortical fibers. N_{70} refelects the activity of fovea and primary visual cortex while N_{155} reflects the activity of visual association areas 18 & 19 [4].

VEP has been influenced by various factors. Age has been reported to influence latency of P_{100} at a rate of 2.5 ms/decade after 5th decade [7]. Iinfant and young children latency is longer and reaches adult value by 5-6 years. In infants amplitude is almost double of adult value [4].

Various studies on VEP have shown variation in VEP with age and sex in pediatric population. N1 amplitude increases significantly with age, whereas N1 latency showed a small age related decrease [8]. Some studies reported no gender and eye differences in VEP latency and amplitude [9].

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Although various studies have been done on visual evoked potential but there are few studies from India only. Therefore this study was planned to study visual evoked potentials by recording battery of N_{70}, N_{100} & N_{155} waveform in different age groups of normal healthy children. Study also comprises the differences in visual evoked potentials in relation to gender and eye dominance.

Material & Methods

Present study was conducted in department of Physiology of Tertiary care teaching hospital. 50 healthy patients were included in two groups

Group 1: 4 to 5 years of age

Group 2: 6 to 20 years

Children below 4 years were excluded from study because they could not cooperate in maintaining fixation of eye at central point of checker board screen. This is an important pre requisite for recording pattern visual evoked potential [9].

Procedure of VEP recording: VEP were recorded in all subjects on a particular machine under similar laboratory conditions after they were acclimatize to the experimental conditions. The nature of the test was explained to them to allay fear and apprehension. The subject were informed about study and written and Verbal consent was taken.

Visual evoked Potential recordings were performed in a dark and sound attenuated room in a laboratory. The subject was asked to sit comfortably in front of the checkerboard pattern at an eye- screen distance of 100 cm. The stimulus pattern was a black and white checkerboard displayed on a computer screen. The checks alternate from black/white at the rate of approximately twice per second. The subject was instructed to gaze at red color dot on the centre of checkerboard pattern. Each eye was tested separately. Every time when there was alteration in the pattern, the subject visual system generated an electrical response which was recorded using electrode [10].

For performing VEP test standard disc EEG electrode were used. These electrode were made of standard silver surface connected to a wire which was plugged into the machine [6].

The skin was prepared by degreasing. The recording electrode was place at highest point on the occiput using the conduction jelly or electrode paste. [O_Z electrode was located in the middle of the variation zone of calcarine fissure i.e. at the highest point on the occiput].

Results

Table 1: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency(ms) of N_{70} Waveform Between Group I and Group II

	Group I		**Group II**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
N_{70} Amplitude(μv)						
Mean	11.5	11.8	13.6	12.25	0.049*	$>0.05^{NS}$
± SD	2.97	2.75	4.27	3.91		
N_{70} Latency(ms)						
Mean	63.74	66.28	63.84	64.64	$>0.05^{NS}$	$>0.05^{NS}$
± SD	4.29	4.97	3.5	4.85		

**statistically significant; NS-not significant*

Table depicts that mean value for amplitude of N_{70} wave between group 1 and 2 is statistically significant in left eye.

Table 2: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency (ms) of N_{155} Waveform Between Group I and Group II

	Group I		**Group II**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
P_{155} Amplitude(μv)						
Mean	12.4	13.2	11.7	14.75	$>0.05^{NS}$	$>0.05^{NS}$
± SD	3.85	4.24	3.44	4.85		
N_{155} Latency(ms)						
Mean	154.48	157.5	154.15	152.76	$>0.05^{NS}$	0.01*
± SD	8.62	7.12	5.13	5.13		

**statistically significant; NS-not significant*

Table depicts that mean value for latency of N_{155} wave between group 1 and 2 is statistically significant in right eye. All other parameters are statistically insignificant.

Table 3: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency (ms) and duration (ms) of P_{100} Waveform Between Group I and Group II

	Group I		**Group II**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
P_{100} Amplitude(μv)						
Mean	13.1	41.2	14.4	16.9	$>0.05^{NS}$	0.027
± SD	3.32	4.19	2.42	4.16		
P_{100} Latency(ms)						
Mean	94.66	93.44	96.7	96.52	$>0.05^{NS}$	$>0.05^{NS}$
± SD	7.52	7.27	7.31	9.68		
P_{100} duration (ms)						
Mean	76.2	81.0	81.0	80.4	$>0.05^{NS}$	$>0.05^{NS}$
± SD	11.39	9.68	9.68	8.52		

**statistically significant; NS-not significant*

Table depicts that mean value for amplitude of P_{100} wave between group 1 and 2 is statistically significant in right eye. All other parameters are statistically insignificant.

Table 4: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency(ms) of N_{70} Waveform between Males and Females of Group I

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
N_{70} Amplitude						
Mean	10.38	10.76	12.7	12.91	0.049*	0.049*
± SD	2.46	2.57	3.1	2.57		
N_{70} Latency						
Mean	61.79	66.83	65.85	65.68	0.014*	>0.05NS
± SD	3.97	5.2	3.68	4.85		

**statistically significant; NS-not significant*

The data depicts that mean value for amplitude of N_{70} wave between male and female children in group 1 is statistically significant in both eyes. Latency is significantly different in left eye only..

Table 5: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv), Latency(ms) and Duration (ms) of P_{100} Waveform Between Males and Females of Group I

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
P_{100} Amplitude						
Mean	11.34	11.53	15.0	17.08	0.004**	0.000***
± SD	1.94	2.4	3.53	3.81		
P_{100} Latency						
Mean	93.43	92.16	95.98	94.82	$>0.05^{NS}$	$>0.05^{NS}$
± SD	5.75	5.51	9.14	9.79		
P_{100} Duration						
Mean	75.0	79.61	77.5	82.5	$>0.05^{NS}$	$>0.05^{NS}$
± SD	12.24	11.2	10.76	7.83		

statistically significant; NS-not significant; **/*-highly significant*

The data depicts that mean value for amplitude of P_{100} wave between male and female children in group 1 is statistically significant in both eyes.

Table 6: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency(ms) of N_{155} Waveform between Males and Females of Group I

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
N_{155} Amplitude						
Mean	11.53	12.88	13.33	13.54	$>0.05^{NS}$	$>0.05^{NS}$
± SD	4.15	5.18	3.42	3.10		
N_{155} Latency						
Mean	152.03	156.24	157.15	158.87	$>0.05^{NS}$	$>0.05^{NS}$
± SD	5.49	7.70	10.69	6.49		

**statistically significant; NS-not significant*

The data depicts that mean value for amplitude and latency of N_{155} wave between male and female children in group 1 is statistically non-significant in both eyes.

Table 7: showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency (ms) N_{70} Waveform between Males and Females of Group II

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
N_{70} Amplitude						
Mean	13.54	12.39	13.65	12.11	$>0.05^{NS}$	$>0.05^{NS}$
± SD	3.91	4.72	7.74	3.20		
N_{70} Latency						
Mean	64.81	66.12	62.95	6.27	$>0.05^{NS}$	$>0.09^{**}$
± SD	3.27	3.27	3.59	1.50		

**statistically significant; NS-not significant*

The data depicts that mean value for latency of N_{70} wave between male and female children in group 2 is statistically significant in right eyes only.

Table 8: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency(ms) and Duration (ms) of P_{100}Waveform between Males and Females of Group II

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
P_{100} Amplitude						
Mean	14.37	18.12	14.42	15.76	$>0.05^{NS}$	$>0.05^{NS}$
± SD	3.39	4.66	1.09	3.44		
P_{100} latency						
Mean	101.10	99.8	92.73	93.5	0.002**	0.27*
± SD	4.48	5.68	7.21	7.45		

**statistically significant; NS-not significant; **-highly significant*

The data depicts that mean value for latency of P_{100} wave between male and female children in group 2 is statistically significant in both eyes.

Table 9: Showing Mean Value, Standard Deviation and Statistical Significance of Amplitude (μv) and Latency (ms) N_{155} Waveform between Males and Females of Group II

	Male		**Female**		**P-value**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
N_{155} Amplitude						
Mean	11.45	16.35	11.92	13.26	$>0.05^{NS}$	$>0.05^{NS}$
± SD	3.44	4.37	3.55	4.93		
N_{155} Latency						
Mean	156.43	154.98	152.06	150.72	$>0.05^{NS}$	$>0.35^{*}$
± SD	5.88	5.21	4.79	4.28		

**statistically significant; NS-not significant*

The data depicts that mean value for latency of N_{155} wave between male and female children in group 2 is statistically significant in right eye.

Discussion

The VEP should be regarded as complementary to clinical examination and neuro- ophthalmological investigations [6]. It is an important tool for diagnosis of neurological and ophthalmological disorders [11]. VEP are helpful in detecting blindness in patients who can not communicate like young infants and children. If repeated stimulation of visual field causes no change in potentials, then subjects brain is not receiving any signals from his or her eyes. In optic neuritis signals are delayed. VEP are also used in investigating basic function of visual perceptions.

VEP are computer generated average brainwave responses to visual stimuli which may be performed in various clinical scenario. Furthermore infants and children with retinal disorder, eye movement disorder, optic nerve dysfunction, delayed visual development, cortical blindness and neurological disorder with ophthalmological manifestation can be assessed [11]. VEP can also measure optic nerve function pre and post craniofacial surgery, which involve manipulation of facial bones.

Tondon et al in his study in school going children between 4 to 15 years used two sets of 256 stimuli with check size 32 alteration rate 1 HZ to each eye and VEP were analyzed. The latency of various components of VEP along with P amplitudes were recorded for right and left eye separately in boys and girls. The normative data was reported and does not show eye and gender differences in children [9].

Fenwick et studied visual evoked response to pattern reversal stimulus latency in 73 children aged between 6 to 11 years. Analysis of data showed that there is no clear relationship between the mean amplitude or latency of evoked response and age. However significant changes were found between linear displacement and linear age for the N65-P95 wave and there was a complex interaction for the same wave between age, sex and eye. There were significant differences in latencies between right and left eye between boys and girls, with boys having longer latency. There were thus both age and sex related differences in the amplitude and N65-P95 wave in 6-11 year old children were observed [12].

In another study conducted on 85 children between 8-15 years to explore the effect of flash intensity and age on evoked potentials revealed N1 amplitude increased significantly with age, whereas N1 latency showed a small age related decrease [8].

Visual process continue to mature well into childhood due to the development of the retina, optic nerve, visual pathway and visual cortex. A study conducted on 41 children from 1.5 months to 7.5 years for visual evoked potential latencies and amplitudes were evaluated to flash, reversal and onset stimulation. Age dependent exponential decrease in latencies to flash, reversal and onset stimulation were seen. For amplitude there was only age dependent increase to onset stimulation. There was a significant correlation between visual evoked potentials and visual aquity for latencies to flash, reversal and onset stimulation [13].

In our study on comparison of group A and B, It was seen that mean value and standard deviation of amplitude of N70 wave in left eye showed significant decrease in age group of 4 to 5 years. No statistically significant difference was seen in value of latencies of N_{70} wave in both the eyes in groups.

It was observed that mean value and standard deviation of amplitude of P_{100} wave in right eye showed significant

decrease in age group of 4 to 5 years. No statistically significant difference was seen in value of latencies and duration of N_{100} wave has been observed.

No statistically significant difference was seen in value of amplitude of N_{155} wave between both groups.

It was observed that mean value and standard deviation of latency of N_{155} wave in right eye in age group of 4 to 5 years was statistically significant.

Conclusion

Age has significantly variable effects on visual evoked potentials beyond the age of 20 years. In children effect is less prominent. Gender has some effect in adolescent only not in young children below 5 years of age. Significantly longer latencies and lower amplitude has been observed in male.

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