

Gender based normative values of pattern-reversal visual evoked potentials in school age children

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Abstract

Background: Male and female brain develops differently. Gender is one of biological variables that influence visual evoked potentials (VEP). Some previous studies support the existence of sex related VEP difference while others not. This study is an attempt to explore if any difference exists in VEP responses between genders of children age seven to 10 years with an additional aim of documenting preliminary normative VEP data.

Methods: This cross-sectional study was done on consenting children taken from parents (n=76; girls, n=41, age = 8.39±1.11 years; boys, n=35, age = 8.40±1.09 years). Pattern reversal VEP of these children was recorded as per standard method. Latencies of N75, P100, and N145 (ms); amplitude of P100 (µV) and ratio; interocular asymmetry (ms) of both eyes were calculated. Unpaired t-test was applied for statistical analysis. Ethical clearance was obtained prior to the study.

Result: Girls had decreased VEP latency of P100 than boys in left eye (108.15±8.42 vs. 112.71±11.17ms, p = 0.046), in right eye (107.71±8.52 vs. 114.46±10.98 ms, p = 0.004), and in combination of both eyes (107.92±8.07 vs. 113.58±10.36 ms, p = 0.009). Likewise, girls had decreased VEP latency of N75 than boys in right eye (67.44±6.77 vs. 71.29±8.07 ms, p = 0.027) and in combined eyes (67.23±5.19 vs. 70.14±7.31 ms, p = 0.047). A gender difference in P100 amplitude was not detected.

Conclusion: Visual evoked potential differs with gender in prepubertal children aged seven to 10 years.

Keywords: PR-VEP, children, sex difference.

1. Introduction

Visual evoked potentials (VEP) are visually evoked electrophysiological signals extracted from the electroencephalographic activity in the visual cortical areas 17, 18 and 19 recorded from the overlying scalp to visual stimulation[1, 2]. The VEP measures the time that it takes for a visual stimulus to travel from the eye to the occipital cortex, which gives an idea of whether the nerve pathways are intact. Inspection of the normal VEP reveals three identifiable waveforms: N75, P100, and N145 and its amplitude.

Visual evoked potentials (VEP) are known to be influenced by several biological variables, including sex.

Some previous studies support the existence of sex-related VEPs differences in children while others do not [3-8]. No authentic report has appeared in the literature regarding the effect of sex in VEP in Nepalese children. The effect of sex on VEPs in the literature was often assessed by the authors as secondary objectives with sample including from children to elderly[9, 10]. While assessing sex difference in their studies the subject number decrease within a given subgroup of children. Moreover, the results of VEP studies in normal subjects should be available in each laboratory using its own stimulus and recording parameters. Therefore, this study is an attempt to explore if any difference exists in VEP responses between genders of children age seven to 10

years (before puberty starts) with an additional aim of documenting preliminary normative VEP data.

2. Materials and methods

Healthy subjects of girls $n = 41$ and boys $n = 35$ between the ages of seven to 10 years were included in the study. They were carefully examined to exclude any medical illness, visual dysfunction like refractive errors, glaucoma, cataract, uveitis and so on. The study was conducted in Neurophysiology lab of Department of Basic and Clinical Physiology, B.P.Koirala institute of health sciences (BPKIHS). Subjects were selected from Depot higher secondary school, Dharan using a convenient sampling technique. It was a descriptive cross sectional study conducted from July 2013 to July 2014. Prior to the study, the ethical clearance was taken from institute ethical review board of BPKIHS. Similarly, consent from the school and parents were taken for the participation in the study.

Pattern reversal visual evoked potential (PR-VEP) was recorded according to queen square system. Midline-occipital (MO) electrode, the active electrode is 5 centimetre (cm) above the inion for single channel recording. Recommended montages used were right occipital (RO) = 5cm right of the MO, left occipital (LO) = 5cm left of the MO. The reference electrode midline frontal was placed 12cm above the nasion. Earthing electrode was placed on vertex (CZ). All electrode sites were cleaned with skin pure to reduce the skin resistance. The electrodes were filled with Nihon Kohden Elefix gel, which acts as electrical conductor and was stabilized using the electrodes in scalp.

The subjects were instructed to sit on a chair in front of the T.V. monitor at a distance of 100cm. ONIDA14" television displaying black and white pattern reversal checkerboards were used as a visual stimulator. Small white squared fixation point in the center of the checkerboard was utilized for fixing the gaze and television was connected to the Nihon Kohden machine to record the waves of VEP. Subjects were asked to fix their one eye on the central white fixation point and to cover the order eye with hand gently. Checker size was 8° (stimulus field size) and visual field angle was 66 min of arc. Filter was provided creating window of 1-100Hz. Thus, PR-VEP was recorded from Nihon Kohden Machine (NM-420S; H636, Japan). Signals were averaged 200 times by machine automatically which minimizes the signal to noise ratio. The reversal rates for pattern were set at 1Hz with analysis time of 300 ms. The recording procedure was of approximately 45 min duration. The record of the VEPs for each eye was done by channel-1 (RO-MF) and channel-2 (LO- MF) designated as A₁, A₂ waves respectively. Recording were repeated where waves were designated as B₁, B₂ for channel-1 and channel-2 to

check the reproducibility of waveform. Similar, repetition of recording were done for the other eye.

Recorded variables were anthropometric variables: age (year), height (m), weight (kg) BMI (kg/m²) and VEP variables: N75, P100, N145 latency (ms) and amplitude of P100 (μV) of right and left eye.

2.1 Data analysis and statistical analysis

The data was entered in the Microsoft excel (version 2007). Then it was exported to the SPSS version 16 for further analysis. Mean, median (Inter quartile range), mode and SD were calculated for anthropometric and VEP variables. Unpaired t test was used to compare the variables between girls and boys. A p value < 0.05 was considered significant.

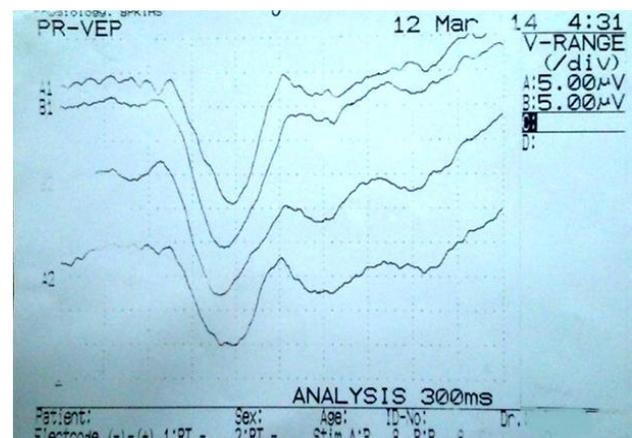


Figure 1: VEP recording of 8 year girl (right eye)

3. Results

The anthropometric variables like age, weight, height and BMI of girls were comparable with that of boys (Table 1).

Table 1: Anthropometric variables of girls and boys

Anthropometric variables	(Mean ± SD)		P value
	Girls n = 41	Boys n =35	
Age, years	8.39±1.11	8.40±1.09	0.174
Weight, kg	24.68±5.1	24.43±4.53	0.806
Height, m	1.24±0.81	1.24±0.77	0.127
BMI kg/m ²	15.94±2.41	15.77±1.69	0.377

3.1 Comparison of VEP variables between girls and boys

The mean latencies (in milliseconds) of waves N70, P100, N145, peak amplitude of P100 (in microvolt) and its related parameters were noted and compared in both the eyes in two groups which is shown in the table (2,3,4)

Table 2: Comparison of VEP variables of left eye between girls and boys (7-10 years)

VEP variables Left eye	Girls n= 41 (Mean ± SD)	Boys n= 35 (Mean ± SD)	P value
P100 Latency, ms	108.15±8.42	112.71±11.17	0.046
N75 Latency, ms	67.02±5.81	69±9.21	0.26
N145 Latency, ms	160.39±15.32	158.91±17.48	0.696
100 Amplitude, μV	16.12±5.87	14.43±5.62	0.205

Table 3: Comparison of VEP variables of right eye between girls and boys (7-10 years)

VEP variables Right eye	Girls n= 41 (Mean ± SD)	Boys n= 35 (Mean ± SD)	P value
P100 Latency, ms	107.71±8.52	114.46±10.98	0.004
N75 Latency, ms	67.44±6.77	71.29±8.07	0.027
N145 Latency, ms	160.02±17.23	163.23±20.69	0.464
P100 Amplitude, µV	16.29±5.68	14.29±5.49	0.123

Table 4: Comparison of VEP variables of both eyes (combined) between girls and boys (7-10 years)

VEP variables Both eyes	Girls n= 41 (Mean ± SD)	Boys n= 35 (Mean ± SD)	P value
P100 Latency, ms	107.92±8.07	113.58±10.36	0.009
N75 Latency, ms	67.23±5.19	70.14±7.31	0.047
N145 Latency, ms	160.2±15.43	161.07±18.43	0.825
P100 Amplitude, µV	16.2±5.61	14.35±5.36	0.148
P100 Difference of left & right eye latency, ms	0.44±5.16	-1.74±7.84	0.151
P100 ratio of left and right eye amplitude	1.02±0.19	0.99±0.19	0.501

The girls have decreased VEP latency of P100 of left eye, right eye, combined eyes than boys; LLP100 (108.15±8.42 vs. 112.71±11.17, $p = 0.046$), RLP100 (107.71±8.52 vs. 114.46±10.98, $p = 0.004$), BLP100 (107.92±8.07 vs. 113.58±10.36, $p = 0.009$). Likewise the girls have decreased VEP latency of N75 of right eye, combined eyes than boys; RLN75 (67.44±6.77 vs. 71.29±8.07, $p = 0.027$), BLN145 (67.23±5.19 vs. 70.14±7.31, $p = 0.047$). The amplitude did not show significant difference but was in increasing trend in girls than in boys.

4. Discussion

We have compared the VEP variables between girls and boys of seven to 10 years. We found that girls showed significantly shorter latencies of VEP P100 of left, right, and combined both eyes than boys. Similarly, latency of VEP N75 of right eye and combination of both eyes in girls showed shorter latency than boys. This shows that there is sex difference in VEP variables (P100 & N75) in children where girls showing shorter latency. The amplitude did not show significant difference but was in increasing trend in girls than in boys.

Most of the previous studies also have demonstrated shorter latency of P100 in girls than boys. Dion *et al*, in their study showed sex-related VEP differences in school-age (11.3 ± 0.6 years) children using achromatic pattern-reversal with different contrast. Girls showed significantly larger amplitudes. In addition, girls showed shorter latencies for the achromatic N75 and P100, regardless of the contrast level[4]. PBC Fenwick and his associates found a significant difference in latencies with the girls having shorter latencies[5].

Likewise, Kazuyoshi *et al* performed pattern reversal visual evoked potentials and found the P100 latency with binocular stimulation was shorter for girls than for boys at the age of 8–11 years[11].

The brains of male and female are indeed different from birth[12]. MRI analysis of a sample of children with the age range of 7-11 years and compared to adults, suggests earlier maturation of brain in female[13]. Some author described brain maturity in terms of the Electroencephalogram (EEG) activity. Matousek *et al*, J. Langrova and his associates showed women have higher relative EEG spectral power in the alpha band and lower power in the theta band which indicate that female brain matures earlier[14, 15]. The difference in VEP P100 latency between the genders is also explained in relation to their head size by the authors. Bruno Gregori and his associates found girls having smaller head size and P100 latency was shorter in girls than boys[16].

In our study, the shorter latencies of VEP P100 and N75 in girls than boys. This can be attributed to (i) early cerebral maturation in girl's children than boys; (ii) evidenced by increase alpha frequency in girls than boys in EEG; (iii) comparatively head size in girls.

P100 latency is the most stable and consistently identified waves in normal subject. Thus, P100 latency is mostly used in diagnostic purpose. In our study, the mean latency (in milliseconds) of P100 wave in normal female child was 108.15±8.42 and 107.71±8.52 in left and right eye respectively. The mean latency of P100 wave in male child was 112.71±11.17 and 114.46±10.98 in the left and right eye respectively. In study done by Kazuyoshi *et al* the latency of P100 wave in children age 8-11 years in female was 111.7±9.1 in left eye and 110.5±6.9 in right eye. In male child it was 113.3±5.9 in left eye and 114.2±6.5 in right eye [11]. Similarly, Dion reported P100 latency of 105.8±6.9 msec for female and 108.9±7.1 msec for male which is done in 11.3±0.6 years of children [4]. The difference in the values in our study and in past literature may be due to the difference in the recording instruments, which differs from institute to institute, therefore there is need for each institute to have its own parameters according to the device.

5. Conclusion

Every neurophysiological laboratory doing VEP studies should have its normative data for future reference. It is clear that predicted normal values in children can vary depending on sex. The generalization of this sex effect is important to take into account for VEP interpretation when using in clinical as well as in research purpose. However, the data present in our study must be cautiously used in clinical settings considering the nature of our sample.

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