Original Article

Preliminary study of visual evoked potential in Thammasat Hospital

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Abstract

Background: Visual evoked potential (VEP) is one of the basic tests for evaluating the function of the visual pathway. In the interpretation, each examination room should have a normal value for comparison, because the normative data of each is not the same.

Purpose: To determine the latency and amplitude of normal VEP between the age of 15 to 70 years.

Materials and methods: The study was conducted in neurological lab of Thammasat hospital on healthy subjects between the age of 15 to 70 years. Pattern-reversal VEP parameters: P100 latency and amplitude (N75-P100) were recorded.

Results: Thirty healthy subjects (male:18, female:12) were included in the study. Range of age between 15 to 68 years (mean:32.5 years). The mean latency in male subjects was 103.10 ± 3.48 and 104.60 ± 4.19 milliseconds in the right and left eye, respectively. The mean amplitude was 14.00 ± 8.28 and 14.40 ± 8.78 microvolt in the right and left eye, respectively. The mean latency in female subjects was 100.70 ± 6.18 and 100.98 ± 5.49 milliseconds in the right and left eye, respectively. The mean amplitude was 15.69 ± 8.64 and 13.79 ± 7.24 microvolt in the right and left eye, respectively.

Conclusion: The present study showed that no significant gender difference in VEP latency and amplitude. In clinical application, there is a difference in the recording instruments and study protocol, which affect the difference in parameters. Therefore, each room should have its normative data for reference.

Key words: Visual evoked potential, Latency, Amplitude

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Introduction

Visual evoked potential (VEP) is an electrical impulse that occurs when stimulated and recorded with an electrode attached to the scalp of the occipital lobe located in the cortical visual area. VEP responses represent electrical impulse from the central visual field because most nerve fibers in the optic nerve receive impulses from the central retina and the macular fibers are terminated in the surface of the occipital cortex while the nerve fibers from the peripheral retina are terminated in the calcarine fissure.[1] Therefore, it is estimated that all VEP responses represent the center visual field and VEP is one of the basic tests for evaluating the function of optic nerve and visual pathway.

In clinical trials, VEP is often used as a transient pattern-reversal VEP primarily because of less change with age.[2] The VEP to pattern stimulation consists of a waveform complex consisting of negative and positive waves. The components of the pattern-reversal VEP are the P100 (100 milliseconds; ms) latency and amplitude (peak to peak of N75-P100 microvolt; μV). Factors affecting VEP testing include electrode factors, stimulus factors, and patient factors. The 15 minute of arc (′) check size is the optimal size to obtain the maximum foveal amplitude while the 60′ check size can stimulate the parafoveal region. The age, gender, pupil size, refractive error, medications and patient's condition may affect the test.[3] The P100 latency is relatively constant and reproducibility in normal population. In general, the normal value of P100 latency is in the range of an average of ± 2.5 SD (standard deviation).

In the interpretation, even if they are normative data, each laboratory room should have a normal value for comparison, because the normative data in each VEP device is different. There are many reports showing the normal values of each device, but the normal values in Thammasat Hospital have not been reported. Currently, the normal values of VEP in the laboratory room of Thammasat Hospital used reference from Keith H. Chiappa. Evoked potentials in clinical medicine. Third edition. Philadelphia: Lippincott-Raven publishers; 1997. The authors would like to study the P100 latency, amplitude, interocular difference and the related factors in healthy subjects who registered at the eye clinic, Thammasat Hospital, Thammasat University. The present study will be beneficial for comparing of VEP values in patients with suspected visual pathway lesions in Thammasat Hospital.

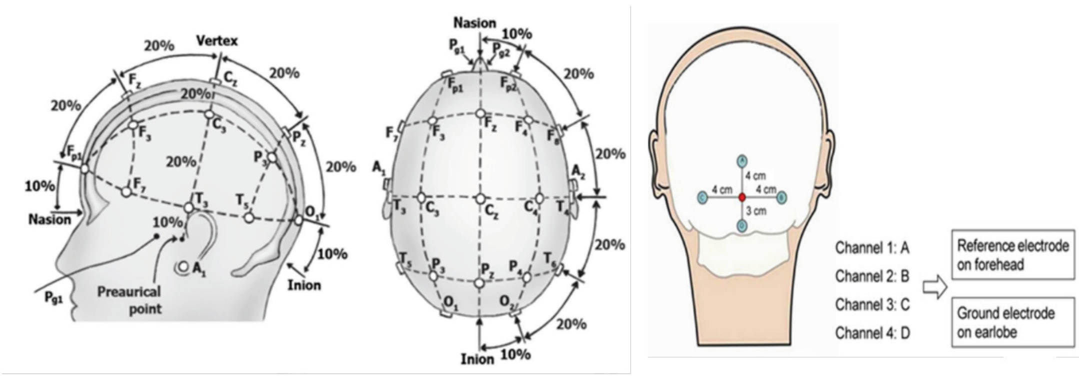
Materials and Methods

The study was approved by the Medical Ethics Committee of Thammasat University (MTU-EC-OP-6-043/60), Pathum thani, Thailand. The study was conducted from 1st June, 2017 to 31th May 2018 in electrophysiology lab of Department of Neurology, Thammasat Hospital. Subjects with normal physical health and normal visual function (best corrected visual acuity 20/20 by Snellen chart, normal pupillary light reaction, normal anterior segment, normal fundus), and no visual complaints were enrolled. The inclusion criteria included healthy subjects of either gender between the age of 15 to 70 years old, no history of optic nerve or brain pathology. Subjects with best corrected visual acuity less than 20/20 by Snellen chart, ocular infection, or subjects who do not cooperate during VEP test were excluded.

Thirty healthy subjects were included in the study. Mean of age was 32.5 years (ranging from 15 to 68 years). Eighteen were male and twelve were female. Data in record form included age, gender, best corrected visual acuity (BCVA) by Snellen chart, anterior segment, pupils, fundus examination, color vision examination by Ishihara pseudoisochromatic plate, average vertical cup:disc (C:D) ratio by optical coherence tomography (OCT) of optic disc, and VEP data: P100 latency (ms) and P100 amplitude (peak to peak of N75-P100, μV), interocular latency, and peak to peak amplitude ratio of right and left eye stimulation. The study protocol was performed with inform consent and the protocol was explained to all subjects before measurement.

Study protocol

The Recording were done in an ambient light room. The scalp and hair must be cleaned and applied a conductive paste to reduce the electrode resistance. The scalp electrodes were placed to bony landmarks and head circumference, according to the international 10 - 20 system.[4] The active electrode is placed about 5 centimeters above the inion (part of the skull of the external occipital protuberance). The reference electrode is placed to the forehead. The ground electrode was placed in the vertex where the midline of the head was intersecting the line drawn through both sides of the ear. The study used the standard single-channel recording, according to the protocol of International Society for Clinical Neurophysiology (ISCEV); midline-occipital (MO) electrode 5 cm above the inion, right-occipital (RO) 5 cm right lateral of MO, left-occipital (LO) 5 cm left lateral of MO, midline-frontal (MF) 12 cm above the nasion (part of the skull between the nasofrontal suture), and (CZ) on vertex as the figure (Figure 1).[5]



1A 1B 1C

Figure 1 The standard single-channel recording according to the International 10-20 System of electrode placement and the ISCEV protocol (1A) the reference electrode is located along the midline at Fz (1B) the lateral active electrodes are located at O1, O2 (1C) the anterior/posterior midline measurements are based on the distance between each channel.

The frequency of transient pattern reversal rate was 2 reversals per second. Both 15′ and 60′ check sizes were performed. The stimulus was displayed on the RETI system configuration Amplifier version2.0 (SMD) computer screen of Nihon Kohden machine (NM-420S; H636, Japan). The subjects stayed away 100 cm from the TV screen with the stimulator and wore glass correction for visualization of fixation point. The computer was amplified 1000 signals and stop automatically. Each record of the eye was repeated to test the reproducibility.

Statistical analysis

We analyzed the data with excel tables (Microsoft windows XP professional version 2002 service pack3) and the statistical analysis was performed with SPSS software version 20.0 (IBM Inc, Chicago, IL). Normative values of P100 latency and P100 amplitude were described in terms of mean ± SD and range. The data was analyzed statistically by unpaired t-test. P-value of less than 0.05 indicated statistical significance.

Results

The comparison of age, BCVA, average vertical C:D ratio from OCT disc between male and female subjects are shown in table 1. Age, BCVA, and C:D ratio were similar in both gender groups. The values of latency and amplitude of P100 wave in normal subjects from both gender groups was given in Table 2.

Table 1 Comparision of age, BCVA, and C:D ratio between male and female subjects

Parameters	Age (years)	BCVA (logMAR)	Average vertical C:D ratio
Males	33.05 ± 18.29	1.0	0.47
Females	31.75 ± 12.58	1.0	0.48
P-value	0.60	0.34	0.78

Table 2 Values of latency and amplitude of P100 wave in both gender groups

Parameter	Right eye		Left eye	
	Latency mean ± SD	Amplitude mean ± SD	Latency mean ± SD	Amplitude mean ± SD
15′ check size	102.2 ± 4.80	14.70 ± 8.32	103.10 ± 4.99	14.10 ± 8.07
	(97.4 - 107.0)	(6.30 - 23.0)	(98.1 - 108.1)	(6.0 - 22.2)
60′ check size	103.80 ± 6.60	13.50 ± 8.55	105.50 ± 6.47	12.20 ± 7.69
	(97.2 - 110.4)	(4.9 - 22.1)	(99.7 - 112.0)	(4.5 - 19.9)

The values of latency and amplitude of P100 wave in normal subjects using the 15′ check size was given in Table 3.

Table 3 Comparision of VEP parameters between male and female subjects with 15′ check size

15′ Check size	Right eye		Left eye	
Parameter	Latency mean ± SD	Amplitude mean ± SD	Latency mean ± SD	Amplitude mean ± SD
Male	103.10 ± 3.48 (99.7 - 106.6)	14.00 ± 8.28 (5.7 - 22.3)	104.60 ± 4.19 (100.4 - 108.8)	14.40 ± 8.78 (5.6 - 23.1)
Female	100.70 ± 6.18 (94.5 - 106.9)	15.69 ± 8.64 (7.1 - 24.3)	100.98 ± 5.49 (95.5 - 106.5)	13.79 ± 7.24 (6.5 - 21.0)
P-value	0.87	0.14	0.63	0.26

The values of latency and amplitude of P100 wave in normal subjects using the 60′ check size was given in Table 4.

Table 4 Comparision of VEP parameters between male and female subjects with 60′ check size

60′ Check size	Right eye		Left eye	
Parameter	Latency mean ± SD	Amplitude mean ± SD	Latency mean ± SD	Amplitude mean ± SD
Male	104.30 ± 4.83 (99.5 - 109.2)	14.50 ± 9.20 (5.3 - 23.7)	106.50 ± 3.86 (102.6 - 110.3)	13.80 ± 8.74 (5.1 - 22.6)
Female	103.08 ± 8.81 (94.3 - 111.9)	12.30 ± 7.61 (4.4 - 19.6)	104.15 ± 9.15 (95.0 - 113.3)	9.77 ± 5.17 (4.6 - 14.9)
P-value	0.20	0.34	0.37	0.10

Discussion

The detection of the optic nerve function revealed checkerboard was the most effective stimuli. In clinical use, the use of two size stimuli is check size about 15′± 3′ and the check size about 60′± 12′.[6] For this reason, we report the normal value of P100 parameters obtained from both small and large check sizes. Results of the present study demonstrated that the P100 latency obtained from the 15′check sizes were shorter as compared to those obtained from the 60′check sizes, and the P100 amplitude from the 15′check sizes were higher as compared to those obtained from the 60′check sizes. Because the 15′ check size is the optimal size to obtain the maximum foveal amplitude, this may explain why we found a longer latency and higher amplitude of P100 obtained from the 15′ check size.

The previous study showed some anthropometric parameters effect on VEP parameters. Guthkelch et al., to study the pattern VEP in 16 healthy adults (8 males, 8 females), it was observed that a major determinant of differences in P100 latency in adults was head size (head length and head circumferences) rather than gender, which may be due to differences in geometry of head rather than to more general biological differences between males and females.[7] However, Sharma et al., reported no significant correlation between VEP parameters and head circumference in both male and female subjects. 8 Therefore, we did not measure a head circumference in the present study.

Results of the present study demonstrated that the P100 latency obtained from both check sizes were slightly longer in males as compared to females, but not significant difference. The P100 amplitude obtained from the 15′check sizes were slightly higher in males in the left eye, but the amplitude was slightly lower in males in the right eye as compared to females. The P100 amplitude obtained from the 60′check sizes were slightly higher in both right eye and left eye as compared to females. However, it was no significant difference in P100 amplitude. Our results were similar to the results of some previous studies which showed no significant gender difference in VEP latency. Mitchell and colleagues studied the age and gender effect in the pattern VEP in 68 normal subjects (31 males, 37 females) with the age range 40-80 years, and they demonstrated that the VEP latency were significantly increase with age, but no gender effect.[9] Tandon and colleagues reported the pattern VEP in school going children with the age range 4-15 years (mean 9.9 ± 2.6 years). The latency and amplitude had no significant gender differences in children.[10]

In contrast, some studies showed gender effect on VEP parameters. The pattern VEP in 123 volunteers with the age range 20 - 77 years revealed that the P100 component demonstrated a shorter mean latency, but a higher mean amplitude for females than males. The P100 latency was suggested having gender effect.[11] Sharma et al., provided the pattern VEP in 100 healthy medical students (50 males, 50 females) with the age range 17-20 years. The result indicated the latencies of N70, P100 and N155 waves were significantly longer in males as compared to females. The amplitude of P100 wave was higher in females in both left and right eye as compared to males.[8] Moreover, sex differences in flash VEP was performed by Kaneda et al. The sex differences in VEP in their study likely to be attributed to genetically determined sex differences in neuroendocrinological systems.[12]

Potential limitations to the present study include the followings :(i) lack of antropometric parameters including height, weight, body mass index (BMI) and head circumference in subjects, even the previous study showed no significant correlation was found between VEP parameters and head circumference; (ii) wide age range and small sample size of both gender groups, both of which might have affected the gender and age difference in VEP parameters. Research limitations Should be caused by education in a relatively wide age range and not many volunteers participating in the research Therefore may not find any differences that exist

As future work, prospective clinical studies and selected protocol for large sample populations was needed for testing this difference.

Conflict of interest

None

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บทคัดย่อ

การหาค่ามาตรฐานในการตรวจคลื่นไฟฟ้าของเส้นประสาทตาในโรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ

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บทนำ: คลื่นไฟฟ้าของเส้นประสาทตาเป็นการตรวจการทำงานของสมองส่วนที่รับภาพ ในการแปลผลต้องมีค่ามาตรฐานในการเทียบ ซึ่งค่าในแต่ละเครื่องมีความแตกต่างกัน

วัตถุประสงค์: เพื่อศึกษาหาค่ามาตรฐานในการวัด latency และ amplitude ในอาสาสมัครที่มีช่วงอายุตั้งแต่ 15 ถึง 70 ปี

วัสดุและวิธีการ: การตรวจทำในอาสาสมัครช่วงอายุตั้งแต่ 15 ถึง 70 ปี ใช้การทดสอบแบบ pattern-reversal ค่าพารามิเตอร์ได้แก่ ค่า latency ที่ 100 มิลลิวินาที (P100) และค่า amplitude ที่ 100 มิลลิวินาที

ผลการศึกษา: อาสาสมัคร 30 ราย เป็นเพศชาย 18 ราย เพศหญิง 12 ราย อายุเฉลี่ย 32.5 ปี (15 ถึง 68 ปี) ในเพศชายค่าเฉลี่ย P100 latency เท่ากับ 103.10 ± 3.48 และ 104.60 ± 4.19 มิลลิวินาที ในตาขวาและตาซ้าย ค่าเฉลี่ย amplitude เท่ากับ 14.00 ± 8.28 และ 14.40 ± 8.78 ไมโครโวลต์ ในตาขวาและตาซ้าย ในเพศหญิง ค่าเฉลี่ย P100 latency เท่ากับ 100.70 ± 6.18 และ 100.98 ± 5.49 มิลลิวินาที ในตาขวาและตาซ้าย ค่าเฉลี่ย amplitude เท่ากับ 15.69 ± 8.64 และ 13.79 ± 7.24 ไมโครโวลต์ ในตาขวาและตาซ้ายตามลำดับ

สรุป: ค่าปรกติไม่มีค่าความแตกต่างของทั้ง latency และ amplitude ระหว่างเพศหญิงและชาย ในทางคลินิกเนื่องจากมีความแตกต่างของเครื่องมือและตัวกระตุ้น ซึ่งมีผลต่อค่าพารามิเตอร์ ดังนั้นในแต่ละแห่งควรมีค่าปรกติเพื่อไว้เป็นค่าอ้างอิง

คำสำคัญ: คลื่นไฟฟ้าเส้นประสาทตา, ค่าความล่าช้าของคลื่นไฟฟ้าเส้นประสาทตาระหว่างสองตำแหน่ง, ค่าเปลี่ยนแปลงขนาดของคลื่นไฟฟ้าเส้นประสาทตาระหว่างจุดสูงสุดถึงจุดต่ำสุด