Original Article

The Normal P100 and P2 Latency of Visual Evoked Potentials among Thai Adults

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Objective: To establish normal values of P100 and P2 latency of visual evoked potentials [VEPs] among Thai adults.

Materials and Methods: A cross-sectional study was conducted among Thai adults without visual abnormalities. The VEPs of participants were tested for both eyes. P100 latency was stimulated from pattern-reversal VEPs whereas P2 latency was stimulated from flash goggled VEPs. The 99th percentile was used as the upper limit of normal.

Results: Among 106 participants (212 eyes), the majority were females (68.9%) with a mean age of 32.1 (10.8) years ranging from 20 to 59 years. The 99th percentile of P100 latency and its interocular latency difference were 119.3 milliseconds and 10.1 milliseconds, respectively. The 99th percentile of P2 latency and its interocular latency difference were 144.3 milliseconds and 17.1 milliseconds, respectively.

Conclusion: The P100 latency exceeding 119.3 milliseconds or interocular P100 latency difference greater than 10.1 milliseconds should be considered as abnormal results. Because of substantial interpersonal variability of flash VEPs, the upper limit of normal of P2 should not be established. However, interocular P2 latency difference greater than 17.1 milliseconds might be considered as abnormality in the eye with longer latency.

Keywords: Visual evoked potential, Normal values, P100 latency, P2 latency, Interocular latency difference

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Visual evoked potentials [VEPs] study is the test that can detect abnormality of central vision at any level of the visual pathway by using light stimulus. It records electrical signal from visual cortex with skin electrode on the scalp and provides the information of functional integrity of the visual system in the form of the waveform on the screen[1-3]. The advantages of VEPs are non-invasive testing, no serious adverse events, low cost, using in both children or adults, and using a visual development testing[4,5].

In clinical practice, there are two common types of stimulus and recording conditions of VEPs, pattern-reversal and Flash VEPs. At least one stimulus protocol should be conducted[1,6]. The waveform of pattern-reversal VEPs consists of negative peaks with a latency of about 75 and 135 milliseconds, which are called N75 and N135, respectively. The prominent positive peak that occurs approximately 100 milliseconds after pattern stimulation is called P100. Flash VEPs consists of negative and positive waves that are designed as a numerical sequence to differentiate the flash VEPs from the pattern-reversal VEPs. The prominent positive peak is P2 and negative peak before P2 is N2[2]. The term of latency is defined as the time from onset of the stimulus to the beginning of a response. Prolong P100 or P2 latency may be due to optic neuropathies such as optic neuritis or demyelinating diseases such as multiple sclerosis[7].

The International Society for Clinical Electrophysiology of Vision [ISCEV] suggested that each laboratory could establish own normal values by using own stimulus and recording parameters[1]. In Thailand, few small studies of normal latency of pattern-reversal VEPs and no study in flash VEPs have been done. In addition, the previous studies did not report the interocular difference in VEPs latency[8,9]. Therefore, the aim of the present study was to establish the normal values of pattern-reversal, and flash goggled VEPs among Thai adults.

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Materials and Methods

Participants

The present study was a cross-sectional study

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conducted between September 2015 and August 2016. Eligibility criteria were Thai adults in the age group between 20 and 60 years without history of visual abnormality. All participants were explained the procedure of the study and signed the informed consents. Participants who had the previous history of injuries, surgeries, or abnormalities of brain or eye were excluded. The Institutional Review Board, Royal Thai Army Medical Department ethically approved the present study protocol.

VEPs studies

The present study used Medelec, Synergy T5EP version 12.2 for setting and recording all parameters. Pattern-reversal and flash goggled VEPs were conducted for all participants in the dark room. The skin was prepared by cleaning with skin prep gel and TEN-20 paste used for stabilized electrical connection. According to International 10/20 System, scalp electrodes were placed relative to bony landmarks and in proportion to the size of the head. Oz was the position of an active electrode placed over the visual cortex. The reference electrode was placed at Fz and ground electrode at Cz. The electrode impedance was less than 4 KΩ.

In pattern-reversal VEPs study, participants seated 100 cm in front of the screen and asked to fix at the small red square in the center of the screen. Visual stimulation by checkerboard that reversed black to white and white to black with fixed repetition rate two reversals per second, filter setting 1 to 100 Hz, 100% contrast, visual angle 20, large check size (8x6), and monocular stimulation were done with 100 responses in both eyes separately. P100 latencies were recorded two times to ensure the reproducibility. The average from two sessions was used in statistical analysis.

In flash goggled VEPs study, 100 brief red LED flash stimulations by goggled glass were done twice each eye with repetition rate 2 Hz, LED intensity 5 photopic candelas second per meter squared ($cd.s/m^{-2}$) and 2 milliseconds in duration. During monocular stimulation, participants asked to fix on brief flash on left and right side, respectively. P2 latencies were recorded two times to ensure the reproducibility. The average from two sessions was used in statistical analysis.

Statistical analysis

The descriptive statistics were conducted including mean (standard deviation [SD]), median (interquartile range [IQR]), minimum and maximum. The 99th percentile was used as the upper limit of normal.

Table 1. Descriptive statistics of VEPs latency (milliseconds)

Wave (method)	Side	Mean (SD)	Min	Max	99th percentile
P100 (pattern)	Right	103.8 (6.1)	89.4	120.3	
	Left	102.0 (5.7)	90.3	121.7	
	All	102.9 (6.0)	89.4	121.7	119.3
	Interocular difference	2.4 (3.3)*	0.1	13.8	10.1
P2 (flash)	Right	119.0 (14.8)	83.3	151.2	
	Left	119.2 (15.0)	83.9	144.3	
	All	119.1 (14.9)	83.3	151.2	144.3
	Interocular difference	3.3 (5.3)*	0.0	17.8	17.1

VEPs = visual evoked potentials

* Median (IQR)

Results

Among 106 participants (212 eyes), the majority were females (68.9%) with mean age of 32.1 (10.8) years ranging from 20 to 59 years. The mean (SD) of P100 and P2 latency were 102.9 (6) and 119.1 (14.9) milliseconds, respectively. The median (IQR) of interocular latency difference of P100 and P2 were 2.4 (3.3) and 3.3 (5.3) milliseconds, respectively. The 99th percentile of P100 latency and interocular P100 latency difference were 119.3 and 10.1 milliseconds, respectively; whereas the 99th percentile of P2 latency and interocular P2 latency difference were 144.3 and 17.1 milliseconds, respectively (Table 1).

Discussion

The participants were enrolled in only an age group of 20 to 60 years old because the previous study conducted by Allison et al[10,11] found that P100 latency did not change between 20 to 59 years and had a little age-related change in left and right latency differences. Moreover, ISCEV guideline mentioned that typical waveform found in age range between 18 to 60 years[3]. In addition, the results of present study were not categorized by gender because the two previous studies among Thai healthy subjects showed no statistical difference of P100 latency between male and female[8,9].

Abnormal P100 latency were normally considered when the latency exceeding 2.5 to 3 SD beyond the mean, or beyond 95th to 99th percentile. The present study used 99th percentile to establish the upper border of the normal. The P100 latency exceeding 119.3 milliseconds or interocular P100 latency difference greater than 10.1 milliseconds should be considered as abnormal results. However, due to substantial

interpersonal variability of flash VEPs, the absence of responses is the only definitely significant abnormality. However, marked interocular latency difference may be considered as abnormality in the eye with longer latency[12]. Hence, 17.1 milliseconds (99th percentile) of interocular P2 latency difference might be used as a cutoff to determine abnormal flash VEPs. Importantly, VEPs results should be interpreted relate with clinical presentation and other investigations if available.

There were no adverse events from the VEPs study. The strengths of the present study were proper sample sizes and following the standard guideline of ISCEV. However, some weaknesses were found. All participants had no history of visual abnormality. However, they did not receive complete eye examination from ophthalmologist before enrollment because it needed additional hospital visit causing participants inconvenience. Hence, asymptomatic visual impairments could not be completely excluded from the study. Next, the participants were only adult subjects, so the results cannot generalize to the elderly or children. Moreover, laboratories that used hardware/software from different manufactures or different clinical protocols could not employ these normative values.

What is already known on this topic?

There were two studies among Thai health adults reporting mean (SD) of P100 latency, 102.4 (5.5) and 102.9 (6.36) milliseconds.

What this study adds?

The present study reported interocular difference of P100 and P2 latency.

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Potential conflicts of interest

The authors declare no conflict of interest.

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