Ind. J. Physiol. Pharmac., Volume 33, Number 4, 1989

SHORT COMMUNICATION

VISUAL EVOKED POTENTIAL IN YOUNG ADULTS : A NORMATIVE STUDY

O. P. TANDON* AND K. N. SHARMA

Department of Physiology,
University College of Medical Sciences and G. T. B. Hospital,
Shahdara, Delhi - 110 095

(Received on August 20, 1989)

Abstract : It is important to acquire adequate normative data of visual evoked potential before using it as a diagnostic tool. A study using visual evoked potential with pattern (VEP-P) was conducted in Twenty male and seven female young healthy subjects of 17-35 years age. Ag/Agcl electrodes anchored on scalp with collodion at O_1-A_1, O_2-A_2 (10-20 system), with transition skin to electrode impedence kept at <5 K ohms, were connected to MEB 5200 Evoked potential Recorder (Nihon Kohden, Japan). The evoked responses to 256 visual stimuli were recorded using transient pattern reversal (checker size 32′), frequency 1/sec and contrast between black and white checks 67%. The responses were averaged by the computer and absolute peak latency values for P_{100} alongwith other positive and negative waves worked out. P_{100} latency of 95.37±6.85, amp. 6.4±2.38 for males and 91.07±49 msec, amp. 6.88±2.79 μv for females are being reported. The P_{100} latency values of present study are similar to those reported in age and sex matched subjects of the western world, indicating that there are no ethnic variations in P_{100} of VEP.

Key words : visual evoked potential transient pattern reversal P_{100} latency amplitude

INTRODUCTION

Visual evoked potential (VEP) is a very important non invasive tool in detecting abnormalities of visual system. It is not only useful for clinical neurophysiologist or opthalmologist but also for neurologists and neurosurgeons, since many of the neurological disorders present with visual abnormalities. The VEP is primarily a reflection of central 3° to 6° of the visual field projecting onto surface of the occipital lobe (1). As VEP is mostly of foveal origin reflecting cone activity, any abnormality of fovea, cones or its projection to occipital lobe could be assessed by VEP. There are various physical and physiological factors influencing VEP. The physical parameters of visual stimuli (size of checker board, frequency of stimulation, contrast and luminance), size of the pupil and state of refraction, field of vision affect VEP[2-4]. The physiological factors include age, sex, and body temperature[5-6]. Therefore it becomes imperative on part of any clinical neurophysiology lab to control these parameters rigidly in order to obtain reasonable, reproducible and reliable data of VEP in a normative study. It is in this connection and also with the view that such data is lacking in Indians this preliminary study on young adults was conducted.

*Corresponding Author

METHODS

The subjects of the present study were young

healthy medical students and members of the laboratory staff. They were given a thorough eye check up to exclude any eye pathology. The visual acuity and colour vision were tested and those having normal colour vision and 6/6 acuity (with or without glasses) were included in this study. Thus twenty males and 7 females in age group of 17–35 years were subjected to visual evoked potential testing with transient pattern reversal method. Subjects were briefed about the procedure to alleviate their apprehension and assure full relaxation during testing procedure. Each subject was seated comfortably in a quiet darkened room 1 metre away from the screen of a television, and instructed to fixate on a small dot at its centre with one eye while the other eye was covered with a patch. A black and white checker board was generated on the TV screen by an electronic pattern generator housed in MEB 5200 Evoked Potential Recorder (Nihon Kohden Japan). The screen (field) size measured 11° vertically and 14° horizontally at the subject's eye and the check size was 5 L min. Luminance of dark checks was 6.31 ft–L, and of the light checks was 31.6 ft–L giving contrast between black and white checks of 67%. The checks were made to reverse at a rate of 1 Hz and 256 responses were recorded and averaged by the computer of the evoked potential recorder with low and high frequency filters 1–100 Hz and with line filter on. Atleast two trials were always obtained to ensure replicability of the VEP pattern. The absolute latencies of positive and negative waves especially P 100 response were recorded.

RESULTS

The values of latencies of negative waves (N_1, N_2) and positive waves (P_1 & P_2) in these subjects are given in Table I. These values were obtained in response to 32 min check size and frequency 1/sec and 256 responses on each trial averaged separately for each eye. The latency of P_1 (P_{100}) in these subjects with average age of 24.24±8.21 years was 94.25±7.14 (msec), and the amplitude was 6.53±2.44 μv. The females had P100 value of 91.07±7.49 which was on lower side than males having value of 95.37±6 85 msec. The 99% TL (Mean+3 SD) which is regarded as upper limit of normal P100 latency is also given separately for males and females (Table I).

DISCUSSION

There are a number of variables that affect the pattern VEP (1). Various physical parameters of visual stimuli, like checker size, alternation rate of the pattern, luminance and contrast level, influence VEP (2–4). So these have to be carefully controlled for any normative study. In the present study these parameters were spelled out and kept constant for each subject. Other factors that affect the pattern VEP include refractive error, pupil size, level of adaptation and age of the subjects (5–6). As mentioned, these subjects were evaluated by ophthalmologist for any such defect and those having normal refraction, pupil size and reaction were included in the study. So by all means, these

TABLE I : Showing values of various waves of VEP-P in 27 adults (Mean±SD).

Sex	*Age (yrs)*	N_1	$P_1(P_{100})$	N_2	P_2	*Amp* P_1
Male (n=20)	23.72±8.5	75.72±7.86	95.37±6.85	124.75±10.50	150.30±12.64	6.40±2.38
Female (n=7)	25.71±7.7	71.35±6.3	91.07±7.4	117.07±10.04	149.28±17.53	6.88±2.79
Total	24.24±8.2	74.59±7.62	94.25±7.14	122.75±10.75	150.77±13.73	6.53±2.44

	P_{100} Latency (msec)	
	Mean	99%TL
Male	95.37	115.32
Female	91.07	113.54

variables were suitably controlled for this study. Regarding recording site of VEP in the scalp, it has been recently reported that distortion of P100 with N100 occurs if full field stimuli are recorded using standard 0z–Fz or 0z–Cz montage (7). Therefore it is advised that either noncephalic or relatively inactive cephalic reference point should be used. In the present study where O1–A1 and O2–A2 montages were used, ear lobule (A1 and A2) were used as reference points. So the distortion element in recording P100 was minimised.

Values of P100 latency similar to what are being reported in this study have been worked out using O1 and O2 as recording sites (8–10) (Table II) Some workers suggest that P100 latencies could be correlated with head size particularly occipito-frontal circumference (OFC) and the gender differences if any, may be dependent upon OFC in males and females (9). The sex differences of P100 latency of the subjects of this study were not statistically significant as the number of female subject was too small (Table I). Sex differences in P100 have been reported by others (11). The females have shorter P100 latency which might be due to shorter axial eye length in them as compared to males (12). Others suggested that smaller brain size in female may account for shorter latency and higher amplitude of P100 (13). There may not be any gender differences in P100 in males with same OFC as females (11). So it will be very appropriate to record head parameters (like OFC, Nasion to inion length) along with head circumference, in subjects selected for conducting a normative study. The observations made in present study suggests that as P100 values of Indian adults are similar to Western adults, there is no ethnic variation in VEP.

TABLE II : Showing comparative values of P_{100} latency and amplitude in adults.

Author	*Recording Montage*	*No. of subjects*	*Age (yrs)*	*P_{100} latency (msec)*		*Amp. (μv)*
					99%TL	
Celesia et al (8)	Fz-Oz	112	(20-75)	98. 1±4.4		9. 9±5.9
Guthkelch et al (9)	Fz-Oz	16	Adults	100.04±3.9		
	Fz-O_1 & O_2	16	—do—	101.35±4.41		
Shih et al (10)	Oz M(1+2)	30	Adult (Male)	107	116	6. 4±2.3
			(Female)	106	113	
Present study	O_1 A_1 & A_2	27	17-35 (Male)	95. 3±6.8	115.3	6.88±2.7
			(Female)	101.07±7.4	113.5	

REFERENCES

1. Sokol S. Visual evoked potentials. In : Electrodiognosis in clinical Neurology 2nd Ed. Aminoff M. J. (Ed). Churchill Livingstone New York 1986, 441-66.
2. Sokol S. The visually evoked potentials : theory, techniques and clinical applications. *Surv Opthalmol* 1976; 21 : 18-44.
3. Regan D. Assessment of visual acuity by evoked potential recordings : ambiguity caused by temporal dependence of spatial frequency selectivity. *Vision Res* 1978; 18 . 439-43.
4. Millodot M, Riggs LA. Refraction determined electrophysiologically responses to alternation of visual contours. *Arch Opthalmol* 1970; 84 : 272-8.
5. Sokol S, Jones K. Implicit time of patterned evoked potentials in infants, an index of maturation of spatial vision. *Vision Res* 1979; 19 : 747-55.
6. Moskowitz A, Sokol S. Developmental changes in the human visual system as reflected by the latency of the pattern reversal VEP. *Electroencophalogr Clin Neurophysiol* 1983; 56 : 1-15.
7. Spitz MC, Emerson RG, Pedley TA. Dissociation of frontal N_{100} from occipital P_{100} in pattern reversal VEP. *Electroencephalogr Clin Neurophysiol* 1986; 65 : 161-8.
8. Celesia GG, Kaufman D Cone S. Effects of age and sex on pattern electroretinograms and visual evoked potentials. *Electroencephalogr Clin Neurophysiol* 1987; 68 : 161-71.
9. Guthkelch AN, Bursick D, Sclabassi RJ. The relationship of the latency of the visual P_{100} wave to gender and head size. *Electroencephalogr Clin Neurophysiol* 1987; 68 : 219-22.
10. Shih PY, Aminoff MJ, Goodin DS et al. Effect of reference point on VEPs : clinical relevance. *Electroencephalogr Clin Neurophysiol* 1988; 71 : 319-22.
11. Stockard JJ, Hughes JF, Sharbrough FW. Visually evoked potentials to electronic pattern reversal : latency variables with gender, age and technical factors. *Amer J EEG Technol* 1979; 19 : 171-204.
12. Larsen JS. Axial length of the emetropic eye and its relation to the head size. *Acta Ophthal (kbh)* 1979; 57 : 76-83.
13. Allison T, Wood CC, Goff WR. Brainstem auditory, pattern reversal visual and short latency somatosensory evoked potentials, latencies in relation to age, sex and brain and body size. *Electroencephalogr Clin Naurophysiol* 1983; 55 : 617-36.

RESULTS

Changes in AChE activity in certain regions of brain i.e., cerebral cortex, corpus striatum, medulla, cerebellum and hypothalamus in control and DFP treated mice were noted (Table I). DFP significantly inhibited AChE activity in all regions of brain. Enzyme activity was more inhibited in corpus striatum and medulla than other regions of the brain. The effect of DFP on glycogen level in different brain regions is given in Table I. The results showed that glycogen was depleted from cerebral cortex, corpus striatum, medulla, cerebellum and hypothalamus. The glycogen depletion was more in the cerebral cortex than other parts of brain.

TABLE I : Effect of DFP (2 mg/kg i. p.) on acetylcholinesterase activity and glycogen level in certain brain regions of mice. Animals were sacrificed 1 hr after injection. Each value represents mean±SE of six animals.

Parameters	*Corpus striatum* 1	*Medulla* 2	*Cerebellum* 3	*Hypothalamus* 4	*Cerebral cortex* 5
AChE[a]					
Control	28.65±0.88	21.69±0.78	15.03±0.60	10.09±0.48	7.98±0.42
DFP treated	9.18±0.62*	7.08±0.51*	6.13±0.44*	4.25±0.32*	3.86±0.30*
% Inhibition	67.95	67.36	59.21	57.87	51.62
Glycogen (mg/100 g)					
Control	68.75±1.89	88.54±2.85	76.52±2.46	40.22±1.20	45.86±1.33
DFP treated	38.98±1.63*	68.53±2.46*	50.06±2.15*	50.06±2.15*	20.96±1.01*
% Depletion	43.30	22.59	34.57	47.88	54.88

a — μmoles of acetylthiocholine hydrolysed/min/g tissue.
* — Significantly different from controls ($P<0.001$).

DISCUSSION

DFP, an irreversible inhibitor of AChE, inhibited the enzyme activity in various regions of brain in mice (Table I). Corpus striatum was included in the present study as it has high concentration of acetylcholine and AChE and is important in the regulation of motor activity (10, 11). Diminution in the level of AChE activity was associated with depletion of glycogen in all the regions of brain under study in DFP treated mice. Certain organophosphorous compounds increase the concentration of brain cyclic AMP which is involved in the process of glycogenolysis (12, 13). Possibly in the present study, DFP treatment may stimulate to increase the level of cyclic AMP which may be a reason for the depletion of glycogen content in different areas of brain in animals. More depletion of glycogen from cerebral cortex than other regions of the brain indicates the high energy requirement of this region which has also been reported earlier to utilize glycogen rapidly as immediate soure of energy (14, 15, 16). Therefore, the depletion of glycogen may be a compensatory mechanism to provide extra energy on account of hyperexcitability and stimulatory effects in DFP treated mice.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. P. K. Ramachandran, Director, Defence Research and Development Establishment, Gwalior for his interest.

REFERENCES

1. Holmstedt B. Pharmacology of organophosphorous cholinesterase inhibitors. *Pharmacol Rev* 1959; 11 : 567-68.
2. O'Brien RD, Hetnarski B, Tripathi RK, Hart GJ. Recent studies on acetylcholinesterase inhibition. In Mechanism of Pesticide Action (G. K. Kohn ed.), American Chemical Society, Washington, DC, 1974; 1-13.
3. Namba T, Motle GT, Jackvel J, Grob D. Poisoning due to organophosphate insecticide. *Amer J Med* 1971; 50 : 475-92.
4. Kar PP, Matin MA. Duration of diazinon induced changes in the brain acetylcholine of rats. *Pharmacol Res Commun* 1971; 3 : 351-4.
5. Husain K, Matin MA. Changes in the level of glycogen and certain enzymes in malathion treated hyperglycaemic rats. *Adv Bios* 1986; 5 : 87-90.
6. Husain K, Mirza MA, Matin MA. Convulsions as the etiology of lactic acidosis in acute diazinon toxicity in rats. *Toxicol Letters* 1987; 37 : 257-61.
7. LeBaron FN. The resynthesis of glycogen by guineapig cerebral cortex slices. *Biochem J* 1955; 61 : 80-85.
8. Montgomy, R. Determination of glycogen. *Arch Biochem Biophys* 1957; 87 : 378-88.
9. Ellman GL, Courtney KD, Andre VJr., Featherstone RM. A new and rapid colorimetric determination of acetylcholinesterase activity. *Biochem Pharmacol* 1961; 7 : 88-95.
10. Matin MA, Husain K. Striatal neurochemical changes and motor dysfunction in mipafox treated animals. *Meth Find Exptl Clin Pharmacol* 1985; 7 : 79-81.
11. Merali Z, Ghosh PK, Hrdina PD, Singhal RL. Alterations in striatal acetylcholine, acetylcholinesterase and dopamine after methadone replacement in morphine dependent rats. *Eur J Pharmac* 1974; 26 : 375-80.
12. Coult DB, Howells DJ, Smith AP. Cyclic nucleotide concentrations in the brains of mice treated with convulsant bicyclic organophosphate. *Biochem Pharmacol* 1979; 28 : 193-6.
13. Sutherland DW, Robinson GA. The role of cyclic 3'5'-AMP in responses to catecholamines and other hormones. *Pharmacol Rev* 1966; 18 : 145-61.
14. Mrsulja BB, Rakic LM. Influence of oxotremorine on glycogen content in various brain structures of rat. *Biochem Pharmacol* 1972; 21 : 1209-10.
15. Sacktor B, Wilson JE, Tickert CG. Regulation of glycolysis in brain in situ during convulsions. *J Biol Chem* 1966; 241 : 5071-5.
16. Siesjo BK. Biochemical correlates of brain structure and function (A. N. Darison ed.), Acad. Press Inc. London, 1977; 175-209.