

Original Article

A Comparative Study of Visual Evoked Potential in immature Cataract and Normal Individuals

Dr Danti J¹, Dr Shivayogappa S Teli², Dr V Deepika³

¹ Postgraduate student, Department of Physiology, Sri Manakula Vinayagar Medical College, Madagadipet, Puducherry – 607105.

² Professor and Head, Department of Physiology, Sri Manakula Vinayagar Medical College, Madagadipet, Puducherry – 607105.

³ Assistant Professor, Department of Physiology, Sri Manakula Vinayagar Medical College, Madagadipet, Puducherry – 607105

Corresponding author: Dr Shivayogappa S Teli, Professor and Head, Department of Physiology, Sri Manakula Vinayagar Medical College, Madagadipet, Puducherry.

Abstract

Title: A Comparative Study of Visual Evoked Potential in Immature Cataract and Normal Individuals

Introduction: Cataract is opacification of crystalline lens in the eye. It is the major cause of blindness worldwide and in India, it accounts for almost 63% of all blind cases. Cataract starts with minimal visual disturbances and eventually progresses to complete blindness if untreated. Visual evoked potentials (VEPs) provide a sensitive method for documenting the abnormalities in the visual pathways. Earlier studies have proven that VEP is useful in identifying optic nerve pathology and opacification of lens in the late stages of cataract i.e. mature cataract. This study was aimed to assess the effect of immature cataract on VEP and compare it with healthy individuals.

Material and Methods: It was a hospital based cross-sectional analytical study. The participants (N=100) were divided in two groups: Group 'A' (control group) with 50 normal individuals and Group 'B' (study group) had 50 individuals with bilateral immature cataract. Pattern reversal visual evoked potential was recorded. VEP Parameters – N₇₅, P₁₀₀ & N₁₄₅ latencies and amplitude of P₁₀₀ (N₇₅-P₁₀₀ and P₁₀₀-N₁₄₅) in study group were compared with control group. The level of significance was tested between two groups using student's t-test.

Results: The latencies of N₇₅ and P₁₀₀ wave were significantly increased (p value = 0.001). The amplitude of P₁₀₀ wave was significantly decreased in study group compared to that of control group (p value = 0.001). Whereas, N₁₄₅ wave latency was decreased but not significant.

Conclusion: We conclude that immature cataract can also affect the visual processing mechanism as evidenced by VEP changes.

Key words: Cataract, Blindness, Visual Evoked Potential.

Introduction

The World Health Organization (WHO) defines blindness as “visual acuity of less than 3/60, or a corresponding visual field loss to less than 10° in the better eye with the best possible correction” and low vision as “visual acuity of less than 6/18 but equal to or better than 3/60, or a corresponding visual field loss to less than 20° in the better eye with the best possible correction.” The term visual impairment includes both blindness and low vision.⁽¹⁾ The

prevalence of visually impaired people all over the world as estimated in 2010 by WHO was 285 million; 39 million were completely blind and other 244 million had low vision. Nearly 90% of this population was from developing countries and about 7 million cases were from India.^(1, 2)

Although the blind population appears to be a huge number, almost 80% of these cases are either preventable or curable.^(2,3)The WHO and the International Agency for Prevention of blindness (IAPB) started a global initiative and a joint program in 1999, "Vision 2020: The Right to Sight" for the elimination of avoidable blindness.⁽²⁻⁵⁾According to a survey by the National Program for Control of Blindness and Visual Impairment (NPCB&VI) in 2006-2007, the main cause for avoidable blindness in India was Cataract which constituted 62.6% of all blind cases. Cataract occurs more frequently with advancing age.⁽⁴⁾ In Tamil Nadu, the estimated prevalence of cataract per 1000 population was 7.3 % in 2005 and about 1. 27 lakhs new cases of cataract are added to the burden each year in India.⁽⁵⁾

Cataract is defined as clouding or opacification of lens in the eye. The opacity in the lens may reduce the visual acuity directly or produce an uneven change in the refractive index of the lens, causing irregular astigmatism and sometimes monocular diplopia. As opacification proceeds, vision steadily diminishes and leads to complete loss of vision if left untreated.^(8,9)

Visual Evoked Potentials (VEPs) are electrical potential differences recorded from the scalp in response to the visual stimuli. They provide a sensitive method for documenting the abnormalities in the visual pathways.^(10, 11)Many studies have proven that VEP is useful in identifying optic nerve pathology and late stage cataract.⁽¹²⁻¹⁴⁾However, very few studies are done in early stages of cataract.⁽¹⁵⁾Hence, this study was conducted to assess the effect of immature cataract on VEP and compare it with age and gender matched healthy individuals.

Materials and Methods:

The permission was taken from the institutional research & ethics committee to conduct the study in the Electrophysiology Research Laboratory of Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital (SMVMCH), Pondicherry. It was a hospital based cross-sectional analytical study.

Based on previous study, the sample size was calculated to be 100. The participants were separated into two groups: Group 'A' (control group) with 50 normal individuals and Group 'B' (study group) 50 individuals with bilateral immature cataract. The study group was selected from the patients attending the Ophthalmology OPD. The purpose and procedure of the study was explained to all in their native language and written consent was taken. After obtaining medical history, a thorough physical examination and fundus examination were performed on all the participants. Individuals with mature cataract, hypertension, diabetes, smokers, alcoholics and patients with presence of glaucoma, vitreous opacities, optic atrophy, and multiple sclerosis were excluded from the study.⁽¹⁶⁻²⁰⁾

The pattern reversal VEPs were recorded using EMG EP MK II equipment (Electromyography, Evoked potential machine, MK II model, Recorders and Medicare System Private Ltd. Chandigarh, India). The recording electrodes (Ag/AgCl) were applied over the scalp as suggested by 10-20 International system of electrode placement: one on the occiput (Oz); another on the vertex (Cz); and last one placed at forehead (Fz).⁽²¹⁾The subjects were asked to sit comfortably in front of the computer screen at distance of 100cm and were instructed to fix their gaze at red colored dot in the centre of checkerboard pattern. Every time there is alteration in the checkerboard pattern, the subject's visual system will generate an electrical response which will be recorded and stored in the computer.

The statistical analysis was done using software SPSS version 24. The level of significance was tested between two groups using student's t-test. The 'p' value < 0.05 was considered statistically significant.

Results:

In group A, 42 % (n=21) were male and 58% (n=29) were female. Whereas in group B 46% (n=23) were male and 54% (n=27) were female. The mean age of group A was 51.12± 7.4 years and Group B was 53.92 ± 7.7 years.

Table-1 shows VEP wave duration (N₇₅, P₁₀₀, and N₁₄₅) between two groups. The P₁₀₀ duration was increased (delay in latency) in all the Group B individuals as compared to Group A and the difference was highly significant. There was also a significant delay in latency of N₇₅ wave and N₁₄₅ wave in the study group.

Table-2 shows VEP amplitudes (N₇₅-P₁₀₀ and P₁₀₀-N₁₄₅) between two groups. The N₇₅-P₁₀₀ and P₁₀₀-N₁₄₅ showed a significant decrease in Group B. The 'p' value of N₇₅-P₁₀₀ amplitude was highly significant in both eyes, whereas 'p' value of P₁₀₀-N₁₄₅ amplitude was significant only in the right eye of study group.

Table-1 shows VEP parameters (Latency of N₇₅, P₁₀₀ and N₁₄₅ waves) of right eye and left eye of both groups. The Values are expressed as mean ± Standard Deviation (SD).

VEP Parameters	Group A (Normal) (n=50) (Mean ± SD)		Group B (Cataract) (n=50) (Mean ± SD)		'p' value*	
	Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye
N ₇₅ (ms)	75.01 ± 9.71	71.20 ± 9.52	80.81 ± 6.05	80.81 ± 6.05	0.01	0.001
P ₁₀₀ (ms)	104.16 ± 1.69	103.95 ± 1.95	109.45 ± 8.34	109.45 ± 8.34	0.001	0.001
N ₁₄₅ (ms)	142.72 ± 7.74	142.75 ± 8.71	146.83 ± 8.71	146.83 ± 14.69	0.83	0.02

* 'p' value <0.05 considered significant

Table-2 shows amplitudes of N₇₅-P₁₀₀ and P₁₀₀-N₁₄₅ in both the groups.

VEP wave Amplitude (µV)	Group A (Normal) (n=50) (Mean ± SD)		Group B (Cataract) (n=50) (Mean ± SD)		'p' value	
	Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye
N ₇₅ -P ₁₀₀ (µV)	7.48 ± 1.99	7.13 ± 1.85	3.77 ± 2.35	3.77 ± 2.35	0.001	0.001
P ₁₀₀ -N ₁₄₅ (µV)	6.35 ± 2.76	6.46 ± 3.18	4.68 ± 2.07	4.94 ± 2.36	0.01	0.08

* 'p' value <0.05 considered significant

Discussion:

The VEPs consist of a series of waveforms: N₇₅, P₁₀₀ and N₁₄₅ wave latency (in milliseconds) and amplitudes of N₇₅-P₁₀₀ and P₁₀₀-N₁₄₅ (in microvolt). They are produced by activity of neurons in the brain to visual stimuli. The generation of P₁₀₀ wave is due to activation of primary visual cortex by the discharge of thalamocortical nerve fibers. N₇₅ wave reflects the activity of foveal stimulation and originates in Brodmann's area 17. Wave N₁₄₅ is due to stimulation of visual association area 18.^(10,11) P₁₀₀ wave is the most prominent wave that shows even small variation between each individual and even in the same individual with repeated measurement. Many factors affect VEP like age, gender, refractive errors, cataract, glaucoma, optic neuritis and systemic diseases like hypertension and diabetes.⁽¹⁶⁻²⁰⁾

In our study N₇₅ and P₁₀₀ waves were significantly prolonged in both the eyes. Whereas the latency of N₁₄₅ wave in left eye showed significant prolongation but in right eye it was not statistically significant. The N₇₅-P₁₀₀ amplitude was significantly decreased and P₁₀₀-N₁₄₅ was also decreased but statistically not significant. Similar results were reported by other researchers as well.^(13, 14, 15)

A study on pattern reversal VEP in middle aged and elderly patients with moderate cataract demonstrated that there was mild delay in P₁₀₀ wave and moderate decrease in amplitude of P₁₀₀(N₇₅-P₁₀₀& P₁₀₀-N₁₄₅). The same study also reported that in dense and mature cataract there was a significant delay in latency of P₁₀₀.⁽¹²⁾ Another study on dense cataract individuals showed delayed VEP especially in latency of P₁₀₀ wave.⁽¹³⁾

These changes in VEP wave pattern in cataract patients indicate that the opacification of lens affects the efficiency of processing of visual information. The possible mechanism for such changes could be due to reduced retinal illumination caused by lens opacification.⁽¹⁸⁾

In contrast to earlier studies, our study participants had only immature cataract i.e. the early stage of cataract. Changes in the VEP in these patients suggest that processing of visual information can be affected from the initial stage of disease.

Conclusion:

Based on the study findings, we conclude that the changes in visual evoked potential in immature cataract were significant and thus emphasize the need of early diagnosis and treatment of cataract before it could slow down the conduction in optic pathway and lead to blindness. We suggest more electrophysiology research has to be done in the future in immature and mature cataract to elucidate the precise role of these conditions on visual processing.

Acknowledgement:

I would like to express my special thanks of gratitude to all the faculties in my department. I also thank our college administration, ophthalmology and community medicine department faculties for their help and support. Lastly, I extend my sincere thanks to all the participants of this study.

Acknowledgements:

I would like to express my special thanks of gratitude to all the faculties in my department. I also thank our college administration, ophthalmology and community medicine department faculties for their help and support. Lastly, I extend my sincere thanks to all the participants of this study.

References:

1. Vision 2020 the right to sight, Global initiative for the avoidable blindness. Action plan 2014-2019: World Health Organization [Internet]. WHO library cataloguing-in-Publication Data, Spain. 2015 [cited on 2018 Dec 1]. Available from: https://www.who.int/blindness/AP2014_19_English.pdf
2. Park K. Text book of preventive and social medicine. 23rd ed. India: M/S banarsidas Bhanet; 2015. Chapter 6, Epidemiology of chronic non communicable diseases and conditions: p.401.
3. Bhaskara Rao Thirunavalli, Usha Rani Chandawada. Text book of community medicine. 3rd ed. India: Paras medical publishers; 2015. Chapter 19, Community ophthalmology: p.683.
4. Gupta p, Ghai O P. Textbook of Preventive and Social Medicine. 2nd ed. New Delhi, India: CBS publishers & Distributors Pvt. Ltd; 2009. Chapter 29, Visual disability: p.529-535.
5. Suryakantha A H. Community Medicine with recent advances. 2nd ed. New Delhi, India: Jaypee Brothers medical Publishers (p) Ltd; 2010. Chapter 26, Blindness: p.513-516.
6. Mariotti S P, Pascolini D, Ophthalmol J. Global estimates of visual impairment: WHO 2010. Visual Impairment and Blindness [Internet]. 2012 [cited 2018 Nov 24]; 96(5):614-8. Available from: https://www.who.int/blindness/data_maps/VIFACTSHEETGLODAT2010full.pdf
7. Lal S, Adarsh, Pankaj. Text book of Community Medicine. 2nd ed. New Delhi, India: CBS Publishers & Distributors Pvt Ltd; 2010. Chapter 13, Blindness: p.606-611.
8. Khurana A K. Comprehensive Ophthalmology. 4th ed. New Delhi, India: New Age International (P) Ltd. Publishers: 2010. Chapter 8, Diseases of the Lens: p.170-204.
9. Ramanjit Sihota, Radhika Tandon. Parson's diseases of the eye. 23rd ed. Elsevier publishers: 2015. Chapter 18, The Lens: p.256-. 279.
10. Pal G k, Pravati Pal. Textbook of Practical Physiology. 4th ed. India: Universities press Private Limited; 2016. Chapter 45, Visual evoked potentials: p.328-331.
11. Misra UK, kalita J. Clinical Neurophysiology. 2nd ed. India: Elsevier publishers; 2006. Chapter 8, Visual evoked potential: p.309.
12. John J S, Alan D C. Delayed Visual Evoked Potential in Adults after Mono ocular Visual Deprivation by Dense Cataract. Investigative and visual science [Internet]. 1995 [cited 2016 Aug 23]; 36(13):2663-2671. Available from: <https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933408/2663.pdf>
13. Jeon J, Oh S, Kyung S. Assessment of visual disability using visual evoked potentials. BMC Ophthalmology [Internet]. 2012 [cited 2018 Aug 06]; 36:9. Available from: https://www.researchgate.net/publication/230621726_Assessment_of_visual_disability_using_visual_evoked_potential
14. G V S Murthy, Sanjeev K Gupta, et al. Current status of cataract blindness and vision 2020; The right to sight ignition in India. Indian J Ophthalmol [Internet]. 2008 [cited on 2018 Mar 28]; 56: 489-94. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2612994/>
15. McCulloch DL, Skarf B. Visual Evoked Potentials Following Early Treatment of Unilateral Congenital Cataract. Arch Ophthalmol [Internet]. 1994 [cited on @018 Dec 03]; 112:510-518. Available from:

https://s3.amazonaws.com/academia.edu.documents/40251939/Pattern_Reversal_Visual_Evoked_Potential_20151121-3492-b6aquu.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1543907560&Signature=iGEm sv%2Fq68%2B2XR4PwoM8w3B9%2FfY%3D&response-content-disposition=inline%3B%20filename%3DPattern_Reversal_Visual_Evoked_Potential.pdf

16. M. Kuba et al. Aging effect in pattern, motion and cognitive visual evoked potentials. *Vision Research* [Internet]. 2012 [cited on 2018 Aug 5]; 62:9-16. Available from <http://de.doi.org/10.1016/j.visres.2012.03.014>
17. Ruby Sharma et al. Visual evoked potentials: Normative values and Gender differences. *Journal of Clinical and Diagnostic Research* [Internet]. 2015 [cited on 2018 Dec 03]; 9(7):cc12-cc15. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4572953/pdf/jcdr-9-CC12.pdf>
18. Anju T J, Parveen S Y, Swarna B G. Effect of myopia on visual evoked potential. *IOSR Journal of Dental and Medical Sciences* [Internet]. 2015 [cited on 2018 Apr 27]; 14(4):49-52. Available from: <http://www.iosrjournals.org/iosr-jdms/papers/Vol14-issue4/Version-7/N014474952.pdf>
19. Jeffrey Froehlich, David I. Kaufman. Effect of Decreased Retinal Illumination on simultaneously recorded Pattern Electroretinogram and Visual-Evoked Potentials. *Investigative Ophthalmology and visual science* [Internet]. 1991 [cited on 2018 Nov 25]; 12 (2):310-318. Available from: <https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933159/310.pdf>
20. Sonron et al. A retrospective study on the outcomes of cataract surgery in an Eastern Regional Health Authority hospital of Trinidad and Tobago. *PeerJ* [Internet]. 2015 [cited on Apr 27]; 3: e1222. Available from: <https://peerj.com/articles/1222.pdf>
21. 10/20 System Positioning Manual. Trans cranial Technologies [Internet]. Trans Cranial technologies ltd, Hong Kong. 2012 [cited on 2016 Aug 31]. Available from: www.transcranial.com