Correlation Between VEP Latency, CDR and PSD On Standard Automated Perimetry In Newly Diagnosed POAG Cases

Shikha Baisakhiya, Gurdev Lal Goyal, Punita Garg, Zahid Khan
Department of Physiology, Department of Ophthalmology, Department of Community Medicine
M.M. Institute of Medical Sciences and Research, M.M. University, Mullana (Ambala), Haryana, India

Aim and Objective: The current study was conducted to find out the correlation between Pattern reversal VEP (visual evoked potential) parameters, standard automated perimeter parameters and cup disc ratio (CDR) in newly diagnosed cases of POAG (primary open angle glaucoma).

Materials and Methods: The study included 72 individuals of both the genders. The subjects underwent routine ophthalmic examination of anterior and posterior segment, IOP (intraocular pressure) measurement, visual field testing by Humphrey’s automated perimeter and Pattern reversal VEP (visual evoked potential) testing. The subjects were classified into mild, moderate and severe based on MD (Mean deviation).

Results: In our study, the mean PSD (pattern standard deviation) and CDR (cup disc ratio) value increased with increase in the severity of glaucoma. The findings of our study also showed that increased PSD and CDR mirrored with increase in P100, N75 and N145 latency and decrease in P100 amplitude. The PSD was positively correlated with the latencies of VEP and negatively correlated with the amplitude of VEP waves (p<0.001).

Conclusion: We conclude that VEP can be used as a reliable tool for monitoring the progression of glaucoma.

Abstract

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Introduction

Primary open-angle glaucoma is a chronic progressive optic neuropathy of multifactorial origin. The diagnostic criteria of POAG is a triad of raised IOP, characteristic visual field defect and cupping of optic nerve head with presence of open angles and absence of any secondary cause of raised IOP. Visual evoked potential (VEP) is an important diagnostic tool that can be used to study the optic nerve head and visual field changes in cases of POAG. Increased latencies and decreased amplitude of VEP both have been documented in cases of glaucoma. The results of the previous studies show a statistically significant correlation between magnitude of change in VEP parameters and PSD on automated static perimetry. The above correlation suggests slowing of neural conduction from retina to the visual cortex in the brain. It also supports the reliability of the usage of VEP test in cases of glaucoma. Researchers suggest that the glaucomatous visual field defect could be attributed to damage of the retinal ganglion cells and their axons. VEP test is compatible with the functions of retinal ganglion cells so it provides specific information. Visual field testing does not selectively reveal the structures of visual pathway involved in the etiopathogenesis of glaucoma. The current goal of treatment of glaucoma patients is neuroprotection. The neuroprotective drugs can help in survival of nonfunctional retinal ganglion cells that are still alive. VEP testing can be used as a diagnostic tool to detect these abnormal nonfunctional retinal ganglion cells and monitor the effect of neuroprotective treatment. The latency of response of retinal ganglion cells is the indicator of their health which can be studied by VEP. As currently existing glaucoma detecting techniques are non-specific, costly, time consuming and subjective in nature so ophthalmologists are always in search of specific and reliable low cost technique. VEP can be used as a potential tool for early diagnosis and follow up of cases of glaucoma. The present study was conducted to find out the correlation between Pattern reversal VEP parameters, standard automated perimeter parameters and cup disc ratio in newly diagnosed cases of POAG and in turn, prove the validity of VEP testing in the diagnosis and follow up of cases of glaucoma.

Methodology

The prospective observational study was conducted on 72 newly diagnosed cases of POAG. The study included subjects of both the genders. The age group of the subjects was above 35 years. The study was undertaken by prior approval from institutional ethics committee. The subjects were selected by random sampling technique. Informed consent was obtained from all the subjects. The inclusion criteria were newly diagnosed cases of POAG having no other ocular abnormality.

Exclusion Criteria

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Subjects with any ocular abnormality, undergone any ocular surgery, on any ocular medication, systemic medication which can affect the IOP, congenital ocular abnormality, history of ocular trauma, inflammation, small pupil size, high refractive errors were excluded from the study. Patients not cooperative for visual field testing and VEP recording were also excluded from the study.

Keywords: VEP latency, primary open angle glaucoma (POAG), pattern standard deviation (PSD), cup-to-disc ratio (CDR)
Experimental Design

A detailed personal history including biodata, habits, past history of diseases, family history were procured from all the subjects. All the subjects underwent complete ophthalmic examination including visual acuity; slit lamp biomicroscopy, optic nerve head examination with 90 D lens IOP measurement with Goldmann Applanation tonometer, pattern reversal VEP recording and 24-2 standard automated perimetry with Humphrey visual field analyzer. The reliability criteria for the visual field were false positive and false negative <33% and fixation losses <20%. The cases were diagnosed as glaucomatous based on optic nerve head abnormality like: asymmetry with the fellow eye (>0.2), cup disc ratio > 0.6, rim notching, retinal nerve fibre layer defect and abnormal GHT (Glaucoma hemifield test). The MD (Mean deviation) and PSD (pattern standard deviation) were used as index of severity of glaucomatous damage. As per Hoddap Parrisch Anderson’s criteria, MD between 0 and -6db is mild glaucomatous damage, -6 to -12 db is moderate glaucomatous damage and >-12db is severe glaucomatous damage. The subjects were categorized as mild, moderate and severe based on MD values. The pattern reversal VEP was performed using 8 by 8 black and white checkboard pattern with red dot in the centre. Responses of 200 stimuli were amplified and averaged. The VEP latency was noted by checking for repeatability on two separate sessions and then averaging the values.

Results

There were total 72 subjects diagnosed with primary open angle glaucoma included in the study. Based on the value of mean deviation (MD), the subjects were classified into mild, moderate and severe glaucoma cases. There were total 27 mild cases, 20 moderate cases and 25 severe cases. The mean CDR of mild glaucoma cases was 0.64±0.035 and the mean PSD was3.47±0.88. The mean value of P100 latency was 105.96±6.81 ms, the mean N75 latency was 64.60±2.95 ms and mean P145 latency was 142.72±6.37 ms. The mean amplitude was 6.02 ±0.70 µv. The mean CDR of moderate glaucoma cases was 0.76±0.063 and the mean PSD was4.55±0.78. The mean value of P100 latency was 115.71±6.33ms, the mean N75 latency was 75.93±6.7 ms and mean P145 latency was 3.24±0.90 µv.

Table 1: Mean PSD, CDR and VEP Parameters of the Three Groups

| Category | No | Mean PSD  | Mean CDR  | Mean P100 Latency (ms) | Mean N75 Latency (ms) | Mean N145 Latency (ms) | Amplitude (µv) |
|----------|----|-----------|-----------|-----------------------|----------------------|-----------------------|----------------|
| Mild     | 27 | 3.47±0.88 | 0.64±0.035| 105.96±6.81           | 64.60±2.95           | 135.21±4.07           | 6.02 ±0.70     |
| Moderate | 20 | 4.55±0.78 | 0.76±0.063| 115.71±6.33           | 75.93±4.67           | 142.72±6.37           | 5.58±0.83      |
| Severe   | 25 | 7.8±0.63  | 0.89±0.064| 128.61±5.46           | 85.39±4.89           | 146.63±9.11           | 3.24±0.90      |

Table 1: Mean PSD, CDR and VEP Parameters of the Three Groups

| Category | Pearson Correlation CDR | Sig. (2-tailed) | N | Pearson Correlation PSD | Sig. (2-tailed) | N | Pearson Correlation P100 (Lat) | Sig. (2-tailed) | N | Pearson Correlation N75 (Lat) | Sig. (2-tailed) | N | Pearson Correlation N145 | Sig. (2-tailed) | N | Pearson Correlation Amplitude | N |
|----------|-------------------------|----------------|---|------------------------|----------------|---|-----------------------------|----------------|---|-----------------------------|----------------|---|---------------------------|----------------|---|--------------------------|----|
| CDR      | 1                       | .846           | .803 | .899                  | .649           | .699 | -7.50                      |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
| PSD      | .846                    | 1              | .877 | .864                  | .613           | -849 |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
| P100 (Lat) | .803              | .877           | 1   | .850                  | .655           | -811 |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N75 (Lat) | .899              | .864           | .850 | 1                     | .735           | -787 |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N145     | .649                    | .613           | .655 | .735                  | 1              | -696 |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
| Amplitude | -7.50               | -849           | -811 | -7.87                | -696           | 1    |                             |                |   |                             |                |   |                           |                |   |                          |    |
| N        | 72                      | 72             | 72  | 72                    | 72             | 72  |                             |                |   |                             |                |   |                           |                |   |                          |    |
The severity of visual field defect can lead to delay in the neural conduction from the retina to the visual cortex. The positive correlation between MD, PSD and VEP latencies in cases of glaucoma confirms it. Further on, this also confirms the validity of VEP in testing the progression of glaucoma. The results of our study also reconfirm the above correlation.

VEP testing uses three types of stimuli: flash, full-field pattern reversal, and half-field pattern reversal. The full-field pattern reversal stimulus is used as a usual stimulus in most of the cases, the half-field pattern reversal is used for localization of lesions behind the optic chiasma. Flash VEP is used for uncooperative patients and small children and its latencies are more variable than the pattern reversal type. We have used the full field pattern reversal stimulus in all cases. Subjects not cooperative for VEP testing by pattern reversal method were excluded from the study. The VEP is an excellent non-invasive objective measure to evaluate visual function, although it is not specific at detecting the exact etiology of the defect. VEP can be used as a tool to measure early glaucomatous damage evidenced by delay in conduction and recorded as increased latencies before retinal ganglion cell death occurs.

Kothari et al in their study on 90 POAG subjects found that Visual field index MD (mean deviation) is negatively correlated with P100 latency. POAG affected Pattern reversal VEP by both ways, by increasing the latency of P100, N70 and N135 and decreasing the amplitude N70-P100. In the current study, we also recorded both increase in latency and decrease in amplitude of pattern reversal VEP as the severity of glaucoma increased. The findings of Towle et al suggest a positive correlation between VEP latency, degree of visual field defect, cupping and pallor in optic nerve head. The findings of our study were in accordance with them. The positive correlation was seen between MD and PRVEP latency in a study done by Horn et al and our findings supported their results as well. In a study done by Jha et al, it was observed that the Pattern reversal VEP parameters deteriorated in cases of POAG as measured by increase in the latency, although a variable effect was seen on amplitude by pattern reversal and flash methods. We also observed in our study an increased latency of Pattern reversal VEP parameters with increasing severity of glaucomatous damage as depicted by MD and PSD on visual field testing and increased CDR of optic nerve.

Limitations
We have not included all other types of glaucoma like primary angle closure glaucoma in our study and we have...
also not studied the efficacy of other methods of VEP testing i.e. Flash method.

**Future Perspective**

Future studies can include all types of glaucoma. Comparision can be made between the parameters of VEP by both flash and pattern reversal methods. Longitudinal studies are required for further validation of reliability and efficacy of VEP as a tool for monitoring the progress of glaucoma.

**Conclusion**

The visual field changes as depicted by MD and PSD values and optic nerve head changes depicted by CDR mirror the delay of conduction to the cortex depicted by VEP latencies. From these observations, we conclude that VEP can be used as a reliable tool for monitoring the progression of glaucoma.

**References**

1. Babber M, Baisakhiya S, Manjhi P, Sidhu HK, Sharma N. Comparison of medical versus surgical treatment for newly diagnosed cases of primary open angle glaucoma. *Delhi Journal of Ophthalmology* 2012; 23:109-12.
2. Kothari R, Bokariya P, Singh R, Singh S, Narang P. Correlation of pattern reversal visual evoked potential parameters with the pattern standard deviation in primary open angle glaucoma. *Int J Ophthalmol* 2014; 7:326-9.
3. Kothari R, Bokariya P, Singh S, Singh R. Significance of Visual Evoked Potentials in the Assessment of Visual Field Defects in Primary Open-Angle Glaucoma: A Review. *Neurosci J* 2013; 2013:418320.
4. Towle VL, Moskowitz A, Sokol S, Schwartz B. The visual evoked potential in glaucoma and ocular hypertension: Effects of check size, field size and stimulation rate. *Invest Ophthalmol Vis Sci* 1983; 24:175-83.
5. Parisi V. Neural conduction in visual pathways in ocular hypertension and glaucoma. *Graefe's Arch Clin Exp Ophthalmol* 1997; 235:136-42.
6. Grippo TM, Hood DC, Kanadani FN, Ezon I, Greenstein VC, Liebmann JM, Ritch RA. A comparison between multifocal and conventional VEP latency changes secondary to glaucomatous damage. *Invest Ophthalmol Vis Sci* 2006; 47:5331-6.
7. Jha MK, Thakur D, Limbu N, Badhu BP, Paudel BH. Visual Evoked Potentials in Primary Open Angle Glaucoma. *J Neurodegener Dis* 2017; 2017:9540609.
8. M. J. Aminoff, *Electrodiagnosis in Clinical Neurology*, Churchill Livingstone, 4th edition, pp. 421–449, 1999.
9. Lachenmayer BJ, Vivell PMO. Principles of perimetry. In: Lachenmayer BJ, Vivell PMO, eds. Perimetry and its clinical correlation. New York: Thieme Medical 1993:12-13.
10. Baisakhiya S, Singh S, Mushtaq F. Correlative study of intraocular pressure and body mass index in North Indian subjects. *International journal of Medical and Health Sciences* 2015; 4:453-6.
11. Kothari R, Singh R, Singh S, Bokariya P. The potential use of pattern reversal visual evoked potential for detecting and monitoring open angle glaucoma. *Current Neurobiology* 2012; 3:39-45.
12. K. E. Misulis and T. C. Head, *Essentials of Clinical Neuropsychology*, Butterworth Heinemann, 3rd edition, pp. 201–209, 2003.
13. C. A. Johnson and S. J. Samuels, “Screening for glaucomatous visual field loss with frequency-doubling perimetry,” *Investigative Ophthalmology & Visual Science*, vol. 38, pp. 413–425, 1997.
14. M. J. Aminoff, *Electrodiagnosis in Clinical Neurology*, Churchill Livingstone, 4th edition, pp. 421–449, 1999.
15. Horn FK, Bergua A, Junemann A, Korth M. Visual evoked potentials under luminance contrast and color contrast stimulation in glaucoma diagnosis. *J Glaucoma* 2000; 9:428-37.

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