International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Evaluation of Visual Evoked Potentials and Functional Correlation with Visual Parameters in Patients with Cerebral Stroke at the Time of Diagnosis and in the Post-Recovery Phase

Saranya Srinivasan[1], Ranjitha Gk[2,] Impana Krishnappa

[1]VR fellow, Department of ophthalmology, Bangalore medical college and research institute
[2]VR fellow, Department of ophthalmology, Bangalore medical college and research institute
[3]Consultant obstetrician and gynaecologist, Indiana hospital

OPEN ACCESS

Corresponding Author:

Ranjitha Gk
VR fellow, Department of ophthalmology, Bangalore medical college and research institute.

Received: 02-01-2025
Accepted: 22-01-2025
Available online: 28-02-2025

ABSTRACT

Background Visual impairment is an important but frequently under-recognized consequence of cerebral stroke. Visual evoked potentials (VEPs) provide an objective, non-invasive and quantitative assessment of functional integrity of the visual pathway from the retina to the visual cortex. This study evaluated VEP patterns in patients with acute ischemic stroke at diagnosis and after three months, and assessed their functional correlation with visual acuity, contrast sensitivity and visual field parameters.

Methods This prospective analytical hospital-based study was conducted at the Departments of Ophthalmology and Neurology, Indira Gandhi Government General Hospital and Postgraduate Institute, Puducherry, from July 2022 to July 2023. Thirty-eight patients with stroke diagnosed within two weeks were included. All patients underwent CT/MRI followed by comprehensive ophthalmic assessment comprising best-corrected visual acuity, Pelli-Robson contrast sensitivity, slit-lamp and fundus examination, Humphrey automated perimetry and VEP recording according to the ISCEV protocol. The same investigations were repeated at three months. Paired-sample t-test was used for comparison, with $p<0.05$ considered statistically significant.

Results Thirty-eight patients were studied; 23 (61%) were male and 15 (39%) were female, with a mean age of 59.3 years. Anterior circulation stroke accounted for 82% and posterior circulation stroke for 18%. Visual field defects were present in 55.26% of patients, and all patients with posterior circulation stroke had a field defect. The mean P100 latency was 109.11±10.67 ms in the right eye and 107.87±7.94 ms in the left eye at diagnosis, compared with 108.89±9.02 ms and 107.98±7.54 ms, respectively, at three months. Mean P100 amplitude was 6.47±1.52 µV in the right eye and 6.75±1.15 µV in the left eye at diagnosis, compared with 6.42±1.52 µV and 6.65±1.22 µV at follow-up. Changes in VEP latency and amplitude were not statistically significant. Visual acuity improved significantly in both eyes ($p=0.007$ and $p=0.004$), and contrast sensitivity also improved significantly ($p=0.025$ and $p=0.016$). No significant change was observed in visual field parameters. The thesis reported no significant correlation between VEP patterns and visual parameters overall.

Conclusion In this cohort, conventional pattern VEP did not demonstrate significant change between acute stroke and three-month recovery and did not differ significantly between anterior and posterior circulation stroke. Visual acuity and contrast sensitivity improved, whereas visual field defects persisted. The findings suggest a limited role for conventional VEP in diagnosis or follow-up of ischemic stroke in this small cohort, while emphasizing the value of comprehensive ophthalmic assessment.

Keywords: *cerebral stroke; ischemic stroke; visual evoked potential; P100 latency; P100 amplitude; visual acuity; contrast sensitivity; visual field; anterior circulation stroke; posterior circulation stroke*

INTRODUCTION:

Stroke is a major cause of disability and may produce visual dysfunction in addition to motor, sensory, speech and cognitive deficits. Visual impairment and visual field loss may adversely affect functional independence and quality of life and may remain unrecognized in routine stroke care.

The visual pathway extends from the retina through the optic nerve, chiasm, optic tract, lateral geniculate body and optic radiations to the visual cortex. Because the posterior visual pathway is supplied predominantly by the posterior and middle cerebral arterial territories, visual field abnormalities may correlate with the location and vascular territory of cerebral infarction. The thesis describes automated perimetry as the current gold standard for assessment of visual field defects and VEP as an objective electrophysiological measure of visual pathway function.

VEPs are derived from electroencephalographic activity generated by the visual cortex. P100 latency and amplitude are commonly assessed in clinical pattern-reversal VEP. Previous studies cited in the thesis have reported delayed VEP responses in ischemic stroke and suggested that VEP may provide evidence of functional visual pathway impairment. However, the relationship between conventional VEP findings, visual field loss and other visual parameters in stroke remains uncertain.

The present study was undertaken to evaluate VEP patterns at the time of diagnosis and after three months of recovery and to assess their functional correlation with visual acuity, contrast sensitivity and visual field findings.

Aim

To compare visual field changes, VEP patterns and their functional correlation with visual parameters in patients with cerebral stroke at the time of diagnosis and in the post-recovery phase.

Objectives

- To estimate the prevalence of visual field defects in patients with acute cerebral stroke and their functional correlation with visual parameters.
- To correlate visual field defects with the intracranial site of infarction.
- To compare visual field defects between anterior and posterior circulation stroke.
- To compare visual field defects during the acute phase and at three months.
- To study VEP patterns at the time of diagnosis and after three months of recovery.

MATERIALS AND METHODS

Study design and setting

This was a prospective analytical hospital-based study conducted at Indira Gandhi Government General Hospital and Postgraduate Institute, Puducherry, over 12 months from 1 July 2022 to 1 July 2023. The sample consisted of 38 patients with acute ischemic stroke.

Participants

Patients attending the stroke clinic with stroke diagnosed within two weeks and willing to participate were included. Exclusion criteria were corneal opacities, esotropia or exotropia in primary gaze, recently detected or pre-existing glaucoma, nystagmus, retinal causes of visual field defects, high hyperopia or myopia, inability to sit for examination, aphasia, disorientation or behavioural changes, and unwillingness to participate.

Clinical and radiological evaluation

Age, sex and vascular risk factors including hypertension, hyperlipidaemia, diabetes, coronary heart disease, alcohol use and smoking were recorded. CT or MRI was performed under neurological guidance to identify the infarct, site of lesion and arterial territory, and these findings were correlated with ophthalmic results.

Ophthalmic evaluation

Best-corrected visual acuity was recorded with Snellen's chart and converted to logMAR for analysis. Contrast sensitivity was assessed using the Pelli-Robson chart. Slit-lamp examination and fundus examination with a +90 D lens were performed. Automated visual fields were assessed with Humphrey Field Analyzer. The same panel of investigations was repeated at three months.

VEP recording

VEP was recorded using a PC-based two-channel RMS EMG EP Mark II system with silver-silver chloride disc electrodes according to the ISCEV protocol. Pattern-reversal stimulation used a black-and-white checkerboard reversing at two reversals per second. Patients were positioned 100 cm from the monitor and fixated centrally. Monocular stimulation was performed separately for each eye. P100 latency and peak-to-peak amplitude were recorded; flash VEP was used in patients with poor vision. The study considered a normal mean P100 latency of 103±7 ms and normal mean P100 amplitude of 7.45±1.14 μV.

Visual field reliability and statistics

Reliable Humphrey perimetry was defined according to the study protocol using fixation losses below 20%, false-positive responses below 33% and false-negative responses below 33%. Data were summarized using frequencies, percentages, mean and standard deviation. Paired-sample t-test was used for comparisons between baseline and three-month follow-up. IBM SPSS Statistics version 29.0 was used, with $p<0.05$ considered statistically significant.

RESULTS

Patient characteristics

Thirty-eight patients were included. Twenty-three (61%) were male and 15 (39%) were female. Mean age was 59.3 years, with a range of 27–86 years. Anterior circulation stroke was present in 82% and posterior circulation stroke in 18%. Hypertension was the commonest comorbidity, followed by diabetes mellitus.

Visual parameters

Visual acuity and contrast sensitivity were impaired during the acute phase. Visual acuity improved significantly after three months in the right eye ($p=0.007$) and left eye ($p=0.004$). Contrast sensitivity also improved significantly in the right eye ($p=0.025$) and left eye ($p=0.016$).

Visual field findings

Visual field defects were present in 21 of 38 patients (55.26%). All seven patients with posterior circulation stroke had visual field defects, compared with 14 of 31 patients (45%) with anterior circulation stroke. Homonymous hemianopia was the most common field defect in posterior circulation stroke. Occipital lesions predominantly produced homonymous hemianopia, temporal lesions were associated with superior quadrantanopia and parietal lesions with inferior quadrantanopia. Visual field defects did not significantly improve after three months.

VEP findings

At diagnosis, mean right-eye P100 latency was 109.11±10.67 ms and left-eye P100 latency was 107.87±7.94 ms. At three months, these values were 108.89±9.02 ms and 107.98±7.54 ms, respectively. Mean right-eye P100 amplitude was 6.47±1.52 μV and left-eye amplitude was 6.75±1.15 μV at diagnosis; corresponding three-month values were 6.42±1.52 μV and 6.65±1.22 μV. The thesis reports no statistically significant difference in VEP latency or amplitude between acute and post-recovery assessment and no significant difference between anterior and posterior circulation stroke.

Functional correlation

Paired analysis showed no statistically significant change in right-eye P100 latency ($p=0.127$), left-eye P100 latency ($p=0.069$), right-eye P100 amplitude ($p=0.112$) or left-eye P100 amplitude ($p=0.097$). In contrast, visual acuity and contrast sensitivity improved significantly. The thesis reports that comparison of visual field parameters and VEP patterns at diagnosis and follow-up did not show a significant overall difference ($p>0.05$).

DISCUSSION

The present study demonstrates that visual dysfunction is common in acute ischemic stroke and that conventional VEP findings did not show a significant change during three months of recovery. The study population was predominantly male, with a mean age of 59.3 years, and anterior circulation stroke accounted for most cases.

The prevalence of visual field defects was 55.26%, consistent with the broad range reported in the literature reviewed in the thesis. All patients with posterior circulation stroke had a field defect, supporting the close relationship between posterior circulation lesions and visual pathway involvement. The lesion-field relationship was also anatomically coherent, with occipital lesions predominantly producing homonymous hemianopia and temporal and parietal lesions producing quadrantanopic defects.

The major focus of this study was VEP. Mean P100 latency was approximately 108 ms overall, and mean P100 amplitude was approximately 6.57 μV. Neither parameter demonstrated a statistically significant change between diagnosis and three months. Likewise, no significant difference was identified between anterior and posterior circulation stroke.

These findings differ from some previous observations cited in the thesis. Lee et al. reported delayed first-peak latency in multifocal VEP among patients with microangiopathic ischemic stroke, suggesting subclinical visual pathway dysfunction. Hernandez reported that occipital cortical stroke may be associated with increased P100 latency and reduced amplitude

when axonal involvement is present. Pojda-Wilczek reported longer VEP latency in patients with hemianopia or quadrantanopia and hemiparesis after stroke. These differences may relate to differences in VEP methodology, lesion characteristics, timing of assessment and sample size.

Tobimatsu and Celesia emphasized that VEPs provide reproducible quantitative information regarding visual pathway and cortical function, while noting that full-field pattern reversal is more suited to anterior visual pathway assessment and hemifield stimulation may be more informative for post-chiasmal dysfunction. This is relevant to the present study because conventional full-field VEP may not optimally characterize localized post-chiasmal visual field defects.

The study also demonstrated significant recovery of visual acuity and contrast sensitivity without corresponding improvement in visual field defects. This suggests that different components of visual function may recover differently after stroke. The thesis discusses the possibility that acute cerebral dysfunction or oedema contributes to early reduction in visual acuity and contrast sensitivity, whereas established visual field loss may persist.

The thesis reports a functional correlation analysis involving visual parameters, visual field analysis and VEP patterns. It notes a statistically significant correlation involving visual acuity and VEP P100 latency and amplitude on the left side, potentially reflecting the greater frequency of left-hemisphere stroke in this cohort; however, the overall conclusion of the study was that VEP did not demonstrate a significant correlation with visual field parameters and that its clinical role in ischemic stroke remains limited. This observation should be interpreted cautiously because the sample size was only 38 patients.

Clinical implications

Routine ophthalmic assessment in stroke survivors is important because visual field impairment may be under-recognized. Automated perimetry can identify and characterize field defects, while visual acuity and contrast sensitivity provide complementary information about visual function. Conventional VEP may be useful as an objective electrophysiological tool in selected patients, but the present study does not support its use as a stand-alone marker of diagnosis or recovery in ischemic stroke.

Limitations

- The sample size was limited to 38 patients, restricting generalizability.
- The study was hospital-based and included mild-to-moderate ischemic stroke patients who could cooperate with testing.
- The three-month follow-up was relatively short for assessment of long-term visual recovery.
- Functional imaging such as functional MRI was not performed.
- Ocular motility impairment, nerve palsies and supranuclear ocular pathways were not assessed.
- VEP findings may have been influenced by the use of conventional full-field stimulation for lesions involving post-chiasmal visual pathways.

The study did not include a control group.

Recommendations

Larger prospective studies with longer follow-up should evaluate conventional and multifocal VEP in relation to lesion location, visual field loss and functional outcomes. Studies using hemifield stimulation, functional neuroimaging and objective visual rehabilitation outcomes may better define the diagnostic and prognostic value of VEP in stroke. The thesis also recommends further investigation with larger patient numbers.

CONCLUSION:

In 38 patients with acute ischemic stroke, conventional VEP showed a mean P100 latency of approximately 108.46±8.43 ms and mean P100 amplitude of approximately 6.57±1.52 μV, with no statistically significant change between diagnosis and three-month recovery and no significant difference between anterior and posterior circulation stroke. Visual acuity and contrast sensitivity improved significantly, whereas visual field defects persisted. Overall, the study found no significant correlation between VEP patterns and visual field parameters and suggests that the role of conventional VEP in diagnosis and management of ischemic stroke is limited. Comprehensive ophthalmic and visual field assessment remains important in stroke survivors.

REFERENCES:

1. Rowe F, Brand D, Jackson CA, Price A, Walker L, Harrison S, et al. Visual impairment following stroke: do stroke patients require vision assessment? Age Ageing. 2009;38(2):188-193.
2. Rowe FJ, Wright D, Brand D, Jackson C, Harrison S, Maan T, et al. A prospective profile of visual field loss following stroke: prevalence, type, rehabilitation, and outcome. Biomed Res Int. 2013;2013.
3. Miele DL, Odel JG, Behrens MM, et al. Functional bitemporal quadrantopia and the multifocal visual evoked potential. J Neuroophthalmol. 2000;20:159-162.

4. Betsuin Y, Mashima Y, Ohde H, et al. Clinical application of the multifocal VEPs. Curr Eye Res. 2001;22:54-63.
5. Hernandez A. Evoked Potentials as Neurophysiologic Tools to Evaluate Stroke. J Neurol Stroke. 2015;2(1):00046.
6. Ramani S, Kini DV, Javeli M, et al. Assessment of visual field defects in cerebrovascular disease. Indian J Clin Exp Ophthalmol. 2018;4(1):100-106.
7. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. J Stroke. 2013;15(3):128-134.
8. Jones SA, Shinton RA. Improving outcome in stroke patients with visual problems. Age Ageing. 2006;35(6):560-565.
9. François J, Neetens A. Vascularization of the optic pathway. I. Lamina cribrosa and optic nerve. Br J Ophthalmol. 1954;38(8):472-488.
10. François J, Neetens A, Collette JM. Vascularization of the primary optic pathways. Br J Ophthalmol. 1958;42:65-80.
11. Andrade JBC, Mohr JP, et al. Oxfordshire Community Stroke Project Classification. Eur Stroke J. 2021;6(2):160-167.
12. Handelsmann H, Herzog L, Kulcsar Z, et al. Predictors for affected stroke territory and outcome of acute stroke treatments are different for posterior versus anterior circulation stroke. Sci Rep. 2021;11:10544.
13. Goeggel Simonetti B, Rafay MF, Chung M, et al. Comparative study of posterior and anterior circulation stroke in childhood: results from the International Pediatric Stroke Study. Neurology. 2020;94(4):e337-e344.
14. Lee JI, Gemerzki L, Weise M, et al. Retinal layers and visual conductivity changes in a case series of microangiopathic ischemic stroke patients. BMC Neurol. 2020;20:333. doi:10.1186/s12883-020-01894-y.
15. Pojda-Wilczek D. Visual-evoked potentials in patients with brain circulatory problems. Int J Neurosci. 2015;125(4):264-269. doi:10.3109/00207454.2014.931386.
16. Tobimatsu S, Celesia GG. Studies of human visual pathophysiology with visual evoked potentials. Clin Neurophysiol. 2006;117(7).
17. Choi H, Kim SJ, Kim SY, et al. Comparison of vision-related quality of life in patients with homonymous hemianopia and monocular blindness. Sci Rep. 2022;12:6558. doi:10.1038/s41598-022-10626-w.
18. Rowe FJ, Hepworth LR, Howard C, Hanna KL, Cheyne CP, Currie J. High incidence and prevalence of visual problems after acute stroke: an epidemiology study with implications for service delivery. PLoS One. 2019;14(3):e0213035.
19. Sand KM, Midelfart A, Thomassen L, Melms A, Wilhelm H, Hoff JM. Visual impairment in stroke patients – a review. Acta Neurol Scand. 2013;127(Suppl 196):52-56.
20. Clatworthy P, Warburton EA, Tolhurst DJ, Baron JC. Visual contrast sensitivity deficits in 'normal' visual field of patients with homonymous visual field defects due to stroke: a pilot study. Cerebrovasc Dis. 2013;36:329-335. doi:10.1159/000354810.
21. Santos NA, Andrade SM. Visual contrast sensitivity in patients with impairment of functional independence after stroke. BMC Neurol. 2012;12:90. doi:10.1186/1471-2377-12-90.
22. Pula JH, Yuen CA. Eyes and stroke: the visual aspects of cerebrovascular disease. Stroke Vasc Neurol. 2017;2. doi:10.1136/svn-2017-000079.
23. Fisk GD, Owsley C, Mennemeier M. Vision, attention, and self-reported driving behaviors in community-dwelling stroke survivors. Arch Phys Med Rehabil. 2002.
24. Zhang X, Kedar S, Lynn MJ, Newman NJ, Biousse V. Homonymous hemianopia in stroke. J Neurol Stroke. 2006;2(1):00046.
25. Gray CS, French JM, Bates D, Cartlidge NEF, Venables GS, James OFW. Recovery of visual fields in acute stroke: homonymous hemianopia associated with adverse prognosis. Age Ageing. 1989;18(6):419-421. doi:10.1093/ageing/18.6.419.