Original Article

Comparison Between RETeval™ Hand-Held Flash VEP and Standard Pattern-Reversal VEP in Diagnosing Optic Nerve Diseases

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ABSTRACT

Purpose: To evaluate the clinical applicability of a portable, hand-held flash visual evoked potential (VEP) device in patients with optic nerve disorders.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: This study was conducted at Sardjito General Hospital, from May 2021 to May 2022.

Methods: VEP latencies were compared between two groups of patients diagnosed with optic nerve disorders. Group 1 were evaluated using the RETeval™ hand-held flash VEP device, employing the International Society for Clinical Electrophysiology of Vision (ISCEV) standard flash VEP protocol at 3 cd·s/m². Participants in Group 2 underwent assessment using conventional pattern-reversal VEP (PRVEP). The mean latency was compared between the two groups.

Results: A total of 24 eyes from 19 patients were included. In Group 1, the mean age was 40.9 ± 15.6 years and in Group 2, it was 34.3 ± 9.9 years. The mean best-corrected visual acuity in both groups was 0.9 LogMAR Group 1, mean flash VEP latency was 132.5 ± 27.6 ms. In Group 2, the mean PRVEP latency was 125.0 ± 34.2ms, also indicating delayed conduction. No statistically significant difference was observed between the mean VEP latencies of the two groups (p = 0.559).

Conclusion: The comparison between the RETeval™ hand-held flash VEP and PRVEP revealed no significant difference in VEP latencies. RETeval™ hand-held flash VEP may have potential clinical utility as a practical tool for the assessment and diagnosis of optic nerve disorders, particularly in settings where conventional VEP testing is not readily available.

Keywords: Optic Nerve Diseases, Visually Evoked Potentials (Vep), Optic Neuritis.

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INTRODUCTION

The most common optic nerve disorders are ischemic optic neuropathy and optic neuritis.[1] Optic neuritis involves inflammation of the optic nerve, impairing its capacity to convey visual data from the retina to the brain, resulting in abrupt and frequently significant vision loss.[2] This condition is multifactorial, nonetheless, approximately 70% of acute optic neuritis are associated with multiple sclerosis (MS), a chronic

inflammatory demyelinating disease of the central nervous system including optic nerve.[1,2] Psychophysical assessments, including visual acuity test and standard automated perimetry, are subjective and may exhibit considerable variability, which reduces their accuracy and dependability.[3]Objective evaluation of the visual pathway is made possible by electrophysiological procedures, such as electroretinography (ERG) and visual evoked potential (VEP). VEP is a non-invasive, highly sensitive diagnostic technique for demyelinating diseases.[4,5]

VEP has been utilized in clinical practice since the 1970s for diagnostic, monitoring, and prognostic purposes.[6] It quantifies electrical signals generated in response to a visual stimulus from the retina to the occipital cortex. It demonstrated the conduction time of neuronal activity from the retina to the occipital cortex and is utilized as an assessment of the integrity and functionality of that pathway.[5,7,8]

The VEP pattern is extensively acknowledged as a sensitive indicator of optic nerve diseases, surpassing MRI, contrast sensitivity, Goldmann perimetry, and visual acuity in sensitivity. Ophthalmologists and neurologists broadly concur that the VEP is invariably aberrant in eyes affected by acute optic neuritis.[9]

The International Society for Clinical Electrophysiology of Vision (ISCEV) standard for VEP testing describes three stimulus modalities: pattern-reversal, pattern onset, offset and diffuse flash stimulation.[8] A standard VEP employs many electrodes positioned on the scalp above the visual cortex to measure electrical activity following retinal stimulation. This approach is typically advised for the analysis of P100 latency. P100 denotes the duration for the signal to traverse from the retina to the visual cortex, reflecting the function of axons transmitting along the visual pathway.[7] Decreased latency of VEP accurately signifies impairment in the afferent visual pathway. It can facilitate the diagnosis of optic nerve disorders.[4]

RETeval™ hand-held flash VEP is a portable device that enables the examiner to conduct VEP examinations in a mobile manner, delivering P100 latency results. Literature on the application of this portable, hand-held flash VEP in optic nerve disorders is scarce.[10] To date, studies have mentioned the use of electroretinogram (ERG)[3,11-14] and flash VEP function of the device.[5,15] RETeval™ enables clinicians to rapidly and less invasively record ERGs and VEPs.[13] One study proved that the RETeval™ ERG system is reliable for both clinical and research purposes.[14] A further study demonstrated significant benefits to patients and clinical services by incorporating a RETeval™ ERG screening in referral processes for visual electro-diagnostic tests (EDTs). It significantly decreases patient waiting time for as many as 45% of patients and is safe and applicable in practical clinical settings.[16] Additional research is required to ascertain the reliability of RETeval™ VEP function. Thus, this study aims to compare VEP latency between the RETeval™ hand-held VEP device and standard pattern-reversal VEP (PRVEP) in patients with optic nerve diseases.

METHODS

This cross-sectional study was conducted at Sardjito General Hospital from May 2021 to May 2022. The ethical approval was taken **(Reference no.KE/FK/1014/EC/2025).**During the study period, patients diagnosed with optic nerve disorders, including papillitis, retrobulbar optic neuritis, neuroretinitis, optic atrophy, and toxic optic neuropathy were consecutively enrolled. The inclusion criteria comprised patients aged 10 to 55 years, diagnosed with optic nerve disorders exhibiting symptoms such as unilateral or bilateral vision loss and associated visual field defects. By consecutive sampling method, all patients who met the clinical indications for VEP testing and presented to the clinic during the study period were included. No sample size calculation formula was applied, as all eligible patients were recruited consecutively. Individuals with a prior history of other ocular illnesses were excluded. Participants were divided into two groups. Group 1 underwent testing with the RETeval™ hand-held flash visual evoked potential (VEP) device, performed according to the International Society for Clinical Electrophysiology of Vision (ISCEV) flash VEP protocol at a stimulus intensity of 3 cd·s/m².Group 2 comprised participants referred to the Electromedical Department for standard pattern-reversal VEP (PRVEP) testing. The primary outcome measure of the study was P100 latency. The P100 latencies from the VEP results were analyzed using Independent T-Test in SPSS v27.0 (IBM Corp., Armonk, NY, USA).

Examination Technique consisted of using RETevalTM Hand-held Flash VEP Device. The patient was instructed to gently close or occlude the

Table 1: *Clinical Data and Means of P100 Latencies of Subjects in RETeval™ Hand-held Flash VEP Device Group.*

No.	Diagnosis	Age(years)	Sex	Visual acuity at onset	P100 Latency
1.	Neuroretinitis CMV	33	M	6/9	110
2.	Neuroretinitis CMV	39	F	6/15	170
3.	Optic Atrophy	55	M	1/60	160
4.	Optic Atrophy	55	M	2/60	90
5.	Optic Atrophy	55	M	1/60	135
6.	Optic Atrophy	57	F	2/60	150
7.	Optic Neuritis (papillitis)	51	F	6/30	110
8.	Optic Neuritis(papillitis)	51	F	1/60	115
9.	Retrobulbar Neuritis	32	M	6/20	170
10.	Retrobulbar Neuritis	35	F	6/7.5	150
11.	Traumatic Optic Neuropathy	14	M	1/300	100
12.	Traumatic Optic Neuropathy	14	M	6/30	130
	Mean ± SD	40.9 ± 15.6			132.5 ± 27.6 ms

Table 2: *Clinical Data and Means of P100 Latencies of Subjects in standard pattern-reversal VEP (PRVEP) Group.*

No.	Diagnosis	Age(years)	Sex	Visual acuity at onset	P100 Latency
1.	Optic Atrophy	37	M	6/30	131.7
2.	Optic Neuritis (papillitis)	21	M	6/21	139.5
3.	Optic Neuritis(papillitis)	23	M	2/60	163.5
4.	Optic Neuritis(papillitis)	26	F	6/7.5	75
5.	Optic Neuritis(papillitis)	35	M	1/300	171.3
6.	Optic Neuritis(papillitis)	35	M	6/30	168.3
7.	Optic Neuritis(papillitis)	35	F	1/300	123.3
8.	Optic Neuritis(papillitis)	45	F	1/60	111.6
9.	Optic Neuritis(papillitis)	53	M	1/300	87.6
10.	Retrobulbar Optic Neuritis	26	F	6/9	92.7
11.	Retrobulbar Optic Neuritis	30	F	2/60	148.2
12.	Retrobulbar Optic Neuritis	46	F	6/7.5	87
	Mean ± SD	34.3 ± 9.9			125.0 ± 34.2

non-tested eye, while the examiner positioned and stabilized the handheld RETeval™ device directly in front of the eye being examined to ensure proper alignment and signal acquisition.

RESULTS

A total of twenty-four eyes from 19 patients were qualified the inclusion criteria. There were 12 eyes in each group. In group 1, five (55.5%) participants were male and four (44.4%) were female. In group 2, there were five (50%) males and five (50%) females. The mean visual acuity in both groups was 0.9 LogMAR. The details of both groups are presented in Tables 1 and 2.

In the RETeval™ group, out of 12 eyes, papillitis was seen in 15.4% (n=2), retrobulbar optic neuritis in 15.4% (n=2), neuroretinitis in 15.4% (n=2), optic atrophy in 38.5% (n=4), and traumatic optic neuropathy in 15.4% (n=2) patients. The mean P100 latencies were 112.5 msec for papillitis, 160 msec for retrobulbar neuritis, 140 msec for neuroretinitis, 134 msec for optic atrophy, and 115 msec for traumatic optic neuropathy.

In the PRVEP group, out of 12 eyes, papillitis was seen in 66.6% (n=8), retrobulbar neuritis in 25% (n=3), and optic atrophy in 8.3% (n=1) . The mean P100 latencies were 137.9 msec for papillitis, 109.3 msec for retrobulbar optic neuritis, and 131.7 msec for optic atrophy.

The P100 latencies were prolonged in both groups, indicating that the results were comparable and the two devices may be used interchangeably, depending on patient conditions($p = 0.559$).For example, when assessment must be performed at the bedside or when the patient cannot be transported to the electromedical department.

DISCUSSION

Previous studies show that the flash VEP function in RETeval™ has the potential as a clinical tool for diagnosing chiasmal and retro-chiasmal anomalies.[5,15]

It has considerable time/cost savings which can hasten diagnoses. The present study reveals that the mean p100 latencies in both group 1 and group 2 were prolonged, and the comparison between the two groups was not statistically significant.

The first group used the flash VEP, a device that operates by employing a strobe sequence of flashing light as the stimulus. It aids in determining the integrity of the optic nerve by evaluating the functionality of the visual system, particularly via the lateral geniculate nucleus. The flash VEP may be less sensitive to visual conduction abnormalities and exhibit greater latency variability compared to PRVEP. However, when the subject is unable to cooperate, such as in the case of infants or individuals with compromised mental status, flash VEP would be an appropriate option as fixation is unnecessary.[7,8] They are also useful in the presence of media opacity when the use of stronger non-standard flashes may be helpful to establish the integrity of the visual pathway. Flash VEPs may sometimes indicate abnormalities despite normal pattern VEPs, which can occur in rare cases of optic neuritis, unrecognized retinopathy, and certain forms of optic nerve sheath pathology.[8]

The stimulus in PRVEP consists of a checkerboard pattern with alternating black and white squares. Dark squares transform into light ones and vice versa, without altering the overall luminance of the display. The pattern reverses multiple times, and the outcomes are subsequently averaged. The pattern has a sharp border, and the occipital cortex is particularly sensitive to the patterns, producing a strong and measurable response.[7,8] Because of this, PRVEP is more sensitive than flash VEP to problems in the visual conducting system. However, it is more time-consuming and requires maintaining visual fixation on the center of the pattern.[7,8] Although normal ranges vary and depend on age and laboratory, the normal PRVEP contains a noticeable positive component at around 100 ms (P100).[8]

VEP can assess cortical activity in the visual system in response to flash or pattern stimuli, which may exhibit abnormalities in various forms of optic neuropathy.[17] According to clinical observations and electrophysiological criteria, P100 is the primary and most prominent VEP component, likely produced by feed-forward and feedback processes in the striate and extra-striate cortices.[18,19] The P100 delay is impacted by lesional and non-lesional damage in the optic radiations, as well as acute and distant optic neuritis.[18] About 90% of patients with disorders of the optic nerve, particularly optic neuritis, may have a markedly delayed P100 latency in both PRVEP and flash VEP.[9] This could therefore help confirm the diagnosis of acute optic neuritis. The method involves assessing the conduction time of neuronal activity from the retina to the occipital cortex, with the optic nerve being the principal structure analyzed.[6,18]

The current study demonstrated that the prolonged P100 latencies of the RETeval™ handheld VEP device and the standard PRVEP could both diagnose optic nerve disorders. The results between the two types of VEP were not significantly different, suggesting that both types possess similar efficacy in identifying optic nerve disorders.

To the best of our knowledge, no prior study has compared the portable hand-held VEP with standard VEP in optic nerve disorders. Kim et al, has shown that handheld flash VEP may have clinical utility for poorly mobile, elderly, and/or non-verbal patients with glaucoma but no comparison was done.[10]

This study has several limitations. Its descriptive cross-sectional design precludes causal inference and longitudinal assessment. The inclusion of diverse optic nerve disorders introduced clinical heterogeneity, which may have influenced VEP latency values. Comparison between flash VEP and pattern-reversal VEP involves inherently different stimulus modalities, and observed differences may partly reflect stimulus characteristics rather than device performance alone. The analysis was limited to P100 latency without assessment of other electrophysiological parameters or correlation with clinical and structural measures. Finally, the single-center, non-randomized nature of the study may limit generalizability and introduce selection bias.

CONCLUSION

The P100 latency comparison between the RETeval™ hand-held flash VEP and standard pattern-reversal VEP revealed no significant differences. The study indicated potential clinical utility of the RETeval™ hand-held flash VEP for diagnosing and assessing optic nerve disorders. The device provides flexibility in clinical settings, allowing examinations to be performed at the bedside when patients are unable to be transported to the electromedical department.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(KE/FK/1014/EC/2025).**

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