Original article

Flash Visual Evoked Potential Recording in Patients with Orbital Fracture

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Abstract

Aim: Orbital fractures are complex facial fractures that require careful treatment to prevent visual complications. One suitable technique for assessing visual pathway disturbances in these patients is visual evoked potential. This study aims to record and analyze visual evoked potentials in patients with orbital fractures in order to improve understanding and treatment of this condition.
Materials and Methods: Twenty patients with severe orbital fractures and resulting visual impairment in eleven eyes were referred to Basir Eye Clinic for treatment. The patients, mostly males, were between the ages of 15 and 35. In order to assess their visual function, visual evoked potentials (VEP) were recorded using flash stimulation. The latency (in milliseconds) and amplitude (in microvolts) of the P100 component of the VEP were measured in the patient group and compared to a control group of 11 individuals matched for age and sex who had a healthy visual system.
Results: The mean age of inpatient and healthy groups was respectively 24.25 ± 6.52 and 24.25 ± 6.56. The study included two groups with an equal number of males and females. There, no statistically significant difference in terms of age and sex between the two groups. The best corrected visual acuity (BCVA) showed a large difference between the two groups, with the patients having only light perception ability while the control group had full vision (10/10). The mean latency for VEP100 peak was 130.36 ± 8 in the case group and 99.63 ± 2.33 in the control group. The mean amplitude was 1.27 ± 0.46 in the case group and 4.27 ± 0.78 in the control group. Both the latency and amplitude of VEP100 peak showed significant differences between the case and control groups ($P < 0.001$).
Conclusion: Head trauma can result in eye dysfunction, primarily affecting the visual pathway. One way to diagnose this condition is by measuring the latency and amplitude of the VEP p1000 peak.

Keywords: Orbital Fracture; Visual Disturbances; Flash Visual Evoked Potential.

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Introduction

Orbital fractures are a result of one or more bones surrounding the eyeball breaking. These fractures typically occur after an injury or a blow to the face. As a result, various consequences can arise, such as a decrease in visual acuity, depending on the severity of the injury. Many diagnostic techniques, such as visual electrophysiology, are used to screen patients based on visual damage. It is a fact that electrophysiological techniques i.e. Other methods include electrooculography (EOG), electroretinography (ERG), and visual evoked potential (VEP).

Abdolalizadeh et al. (2023) researched the visual system, specifically the retina, of patients undergoing treatment with anti-epileptic medication. They found that these drugs may have an impact on a specific retinal layer called the retinal pigment epithelium (RPE). The diagnosis of this condition can be determined through the Arden Index (AI) of the Electrooculogram (EOG) test[1]. Sarzaeim F. et al. (2022) investigated the effect of hand-arm vibration on the retina of road drilling machine laborers, as measured by ERG (Electroretinography). Their findings suggest that occupational vibration produced by these machinery may have adverse effects on the human retina, which can be diagnosed by analyzing the amplitude of the ERG b-wave[2]. Ameli S. (2023) found that stroke can cause damage to the visual system mainly the visual pathway which can be measured by VEP parameters mainly latency of VEP P100 peak [3]. Other studies [4-37] prove the usefulness of these techniques in different pathological conditions of the visual system. Sarzamin F. et al. (2022) examined visual pathway disturbances in patients who experienced head trauma using VEP. They utilized flash stimulation in these patients and observed a delay in the latency of VEP, specifically the P100 peak. This delay demonstrated the impact of head trauma on the visual system, particularly the visual pathway [38].

Patients and methods

In this investigation, 20 patients between 15 and 35 years, including 18 males and 2 females who experienced orbital fractures and significant visual impairment in the affected eye were chosen for the case group. The best-corrected visual acuity (BCVA) in the 11 affected eyes was identified as light perception (LP). Visual Evoked Potentials (VEP) using flash stimulation were utilized to evaluate the visual pathway of these patients. Specifically, the latency (measured in milliseconds) and amplitude (measured in microvolts) of the P100 peak in the VEP were recorded for all patients using a Mangoni machine. Electrodes were affixed to the patients to connect them to the machine, with active, reference and ground electrodes situated on the occipital, vertex, and forehead regions, respectively.

A parallel procedure was conducted with a control group consisting of 20 healthy individuals matched in terms of age and sex, in order to analyze and compare the obtained results. The obtained results from both groups were then compared to identify potential disparities between the groups.

Results

Table 1 shows demographic information of the subjects in the case and control groups. As shown, there was no statistical difference between the two groups regarding age (p=0.001) and sex.

Regarding visual acuity, there was a significant difference between the case and control groups. The case group demonstrated light perception ability, while the control group exhibited

Table 1: Demographic information of subjects in the case and control groups

Variable	Number of participants	groups (Mean ± SD)		P value
		Control	Case	
Age	20	24.25 ± 6.56	24.25 ± 6.52	1 *
Sex	Mail	18 (90 %)	18 (90 %)	1 **
	Femail	2 (10 %)	2 (10 %)	

* Based on T Test
** Based on Chi-Square Tests

Table 2: The measured mean latency and amplitude of the VEP P100 peak in case and control groups

Variable	Number of participants	groups (Mean ± SD)		P value*
		Control	Case	
Latency (msec)	11	99.63 ± 2.33	130.36 ± 8	0
Amplitude (μv)	11	4.27 ± 0.78	1.27 ± 0.46	0

* Based on the Mann-Whitney U Test

complete visual acuity.

Table 2 presents the measured mean latency and amplitude of VEP, P100 peak in both the case and control groups. The table indicates a statistically significant difference in the VEP P100 peak in terms of latency (P = 0.001) and amplitude (P = 0.001) between the two groups.

Discussion

Orbital fracture is a severe injury that can result in visual impairment or even blindness. To screen and monitor this condition, the VEP technique is considered suitable. In two relevant studies on injured eyes caused by orbital fracture, the VEP recording technique revealed an increase in implicit time and a decrease in the amplitude of the VEP P100 peak. This technique is widely recognized as an indicator of visual pathway performance [39, 40], suggesting that any form of pathological alterations in VEP parameters can serve as evidence of visual pathway involvement in patients. The references provided in this document may further support the findings of the current study.

Tian Y. et al. (2021) developed a sensitive diagnostic tool to study traumatic optic neuropathy and analyze 137 eyes from 131 patients. The subjects were diagnosed with orbital fractures between 2016 and 2019. The researchers found that the sensitivity of Visual Evoked Potential (VEP) was a significant factor in this study[41], indicating the potential application of this technique. It is worth mentioning that the flash type of VEP is particularly useful for assessing visual pathway function in these patients [42].

Liu S. et al. (2018) evaluated visual function

in patients with orbital fractures. They utilized various diagnostic techniques, including flash VEP. They found pathological changes in the VEP P100 peak, specifically in terms of latency and amplitude. These findings support the results of the present study [43, 44].

Conclusion

The comprehensive evaluation of VEP parameters, especially the flash VEP, stands as a significant aid in assessing the status of the visual pathway in individuals affected by orbital fractures. Such assessments provide valuable insights that can guide clinical decision-making and improve patient management, aiming to prevent visual impairment or blindness arising from these severe injuries. Overall, the flash VEP technique, focusing on P100 peak parameters, represents a promising avenue for diagnosing and monitoring visual pathway involvement in patients with orbital fractures.

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References

1. Abdolalizadeh S, Karami S, Saleh NT, Shushtarian SMM, Mazar RP, Shojaei A. Retinal Pigment Epithelium Screening of Patients Treated with Anti-Epileptic Medications using Electrooculography. Journal of Ophthalmology and Research. 2023;6:08-11.
2. Sarzaeim F, Ojani F, Hojati TS, Shojaei A, Shushtarian SMM. Effect of Hand-Arm Vibration on Retina of Road Drilling Machine Laborers Measured by Electroretinography. Journal of Ophthalmology and Research. 2022;5(2):81-5.
3. Ameli S. Flash Visual Evoked Potential Recording in Patients with Brain Stroke. Journal of Ophthalmology and Research. 2023;6(3):40-4.
4. Shushtarian S, Adhami-Moghadam F, Naser M, Khazaii R, Sobhani S, Shabani S. Electroretinographic Changes in Multiple Sclerosis Patients with Abnormal Visual Evoked Potentials. Journal of Ophthalmic and Optometric Sciences. 2017;1.
5. Naser M, Shushtarian SMM. Need for Visual Pathway Examination of the Patient Prior to Bone Marrow Transplantation. Journal of Ophthalmology and Research. 2020;3(4):75-8.
6. Tajik F, Shushtarian SMM. Electrooculographic and Electroretinographic Changes among Patients Undergoing Treatment with Amiodarone. Journal of Ophthalmic and Optometric Sciences Volume. 2018;2(4).
7. Shushtarian SMM, Mohammad-Rabei H, Raki STB. Effect of Occupational Vibration on Human Retina Measured by Electroretinography. Journal of Ophthalmic and Optometric Sciences. 2018;2(3):14-7.
8. Naser M, Shushtarian SMM. Amplitude and Latency of Electroretinographical Peaks as a tool to predict the Extent of Retinal Degeneration in Retinitis Pigmentosa Patients. Journal of Ophthalmology and Research. 2020;3(3):71-4.
9. Shushtarian S, Kalantari AS, Tajik F, Adhami-Moghadam F. Effect of occupational vibration on visual pathway measured by visual evoked potentials. Journal of Ophthalmic and Optometric Sciences. 2017;1(5):7-11.
10. Keramti S, Ojani F, Shushtarian SMM, Shojaei A, Mohammad-Rabei H. Early Diagnosis of Pathological Changes in Visual System of Prolactinoma Patients Using Visual

Evoked Potential. Journal of Ophthalmology and Research. 2021;4(3):289-93.
11. Sarzaeim F, Hashemzehi M, Shushtarian SMM, Shojaei A. Visual Evoked Potential Findings in Road Drilling Machine laborers. Journal of Ophthalmology and Research. 2022;5(1):43-7.
12. Allahdady F, Amiri MA, Shushtarian SMM, Tabatabaee SM, Sahraei F, Shojaei A, et al. Comparison of visual evoked potential and electro-oculogram tests in early detection of hydroxychloroquine retinal toxicity. Journal of Ophthalmic and Optometric Sciences. 2016;1(1):19-26.
13. Naser M, Shushtarian SMM, Shojaei A, Adlami-Moghdam F. Visual Disturbance in a Patient with Amiodarone Treatment Following Refractive Surgery. Journal of Ophthalmic and Optometric Sciences. 2017;1(3):39-42.
14. Shushtarian SMM, Shojaei A, Adhami-Moghadam F. Visual Evoked Potentials Changes among Patients with Chronic Mustard Gas Exposure. Journal of Ophthalmic and Optometric Sciences. 2018;2(2018):6-9.
15. Shushtarian SM, Mirdehghan M, Valiollahi P. Retinal damages in turner workers of a factory exposed to intraocular foreign bodies. Indian Journal of Occupational and Environmental Medicine. 2008;12(3):136.
16. Keramti S, Javanshir S, Tajik F, Shushtarian SMM, Shojaei A, Abolhasani A. Retinal Screening of Prolactinoma Patients using Flash Electroretinography. Journal of Ophthalmology and Research. 2021;4(4):321-6.
17. Shushtarian SMM, Adhami-Moghadam F, Naser M, Shojaei A. Severe Headache Initiated by Flash Stimulation during Visual Evoked Potential Recording in a Patient with Monocular Optic Neuritis and History of Migraine Headache. Journal of Ophthalmic and Optometric Sciences Volume. 2017;1(4).
18. Shushtarian SM, editor Role of Myelin in Synchronization and Rhythmicity of Visual Impulses. 4th European Conference of the International Federation for Medical and Biological Engineering: ECIFMBE 2008 23–27 November 2008 Antwerp, Belgium; 2009: Springer.
19. Shushtarian SMM. Suitable Stimulation Technique to Record Visual Evoked Potential in Migraine Patients. Journal of Ophthalmic and Optometric Sciences Volume. 2020;4(2).
20. Shushtarian SMM, Hayti Z. Probable Toxic Effect of Sodium Valproate on Retine Using Electroretinogram. Journal of Ophthalmic and Optometric Sciences. 2019;3(4).
21. Hajibeygi R, Shushtarian SMM, Abolghasemi S. Visual Evoked Potential Findings of Sjogren's Syndrome. Journal of Ophthalmic and Optometric Sciences. 2020;4(1):13-7.
22. Shushtarian SMM, Tajik F, Abdolhoseinpour H. Measurement of Visual Evoked Potentials in Patients with Spastic Cerebral Palsy. J Ophthalmic Optom Sci. 2018;2:10-3.
23. Shushtarian SMM, Adhami-Moghadam F, Adhami-Moghadam P, Abdolhoseinpour H. Electrophysiological Eye Examination Changes in a Patient with Sjogren's Syndrome. Journal of Ophthalmic and Optometric Sciences. 2018;2(1):40-3.
24. Shushtarian SMM, Mazar RP, Fadaeifard S. Visual Evoked Potential Recording in a Fatigued and Drowsy Patient under Anti-Seizure Medicine Treatment. Journal of Ophthalmic and Optometric Sciences. 2021;5(1).
25. Adhami-Moghadam F, Talebi-Bidhendi S, Shushtarian SMM. Retinal Screening of Workers Exposed to Mercury Vapor Using Electroretinography. Journal of Ophthalmic and Optometric Sciences. 2020;4(4):34-8.
26. Shushtarian SMM, Dastjerdi MV. Total

Blindness Following Anaphylactic Shock due to Co-Amoxiclav Treatment. Journal of Ophthalmic and Optometric Sciences. 2020;4(4).
27. Shushtarian SMM, Naghitehrani KH, Aflaki F. Diplopia and Flashes of Light Sensation in a Patient with Fragrance Allergy. Journal of Ophthalmic and Optometric Sciences Volume. 2020;4(3).
28. Shushtarian SMM. Flash and Pattern Reversal Checkerboard Visual Evoked Potential Recording in Albinism Patients. Journal of Ophthalmic and Optometric Sciences. 2020;4(3):42-6.
29. Shushtarian SMM, Naghib SJ, Adhami-Moghadam F, Shojaei A. Diplopia and Blurry Vision Following Refractive Eye Surgery: a Comorbidity Case Report. Journal of Ophthalmic and Optometric Sciences Volume. 2020;4(1).
30. Shushtarian SMM, Fatemian N. Large Difference in Latency of Visual Evoked Potential P100 Peak in Case of Pattern and Flash Stimulation in a Multiple Sclerosis Patient. Journal of Ophthalmic and Optometric Sciences. 2021;5(2):73-6.
31. Fatemian N, Adhami-Moghadam F, Shushtarian SMM. Study of Visual Evoked Potentials in Patients Suffering from Exotropia. Journal of Ophthalmic and Optometric Sciences. 2021;5(2).
32. Shushtarian SMM, Mazar RP. Far Distance Blurry Vision Following Rhinoplasty. Journal of Ophthalmic and Optometric Sciences. 2021;5(1):71-4.
33. Sanaie S, Nematian J, Shoushtarian SMM. Study of electrooculogram (EOG) abnormalities in patient with ocular toxoplasmosis. Medical Science Journal of Islamic Azad Univesity-Tehran Medical Branch. 2014;24(1):33-6.
34. Abdolalizadeh S, Ghasemi M, Mohammadzadeh P, Shushtarian SMM, Shojaei A. Retinal Screening of Patients Treated with Antiseizure Medications Using Electroretinography. Journal of Ophthalmology and Research. 2022;5(4):165-7.
35. Shushtarian SMM, Shojaei A, Tajik F. Visual Pathway Disturbances in Rosai-Dorfman Diusese: a Case Report. Journal of Ophthalmic and Optometric Sciences. 2018;2(4):24-6.
36. Shushtarian SMM, Adhami-Moghadam F. Low Vision in a Patient Due to Retinal Dystrophy upon Refractive Surgery. Journal of Ophthalmic and Optometric Sciences. 2021;5(4):53-6.
37. Shushtarian SMM, Dermani FS, Mazar RP. Blurred Vision in a Patient Suffering from Endometriosis and Epilepsy. Journal of Ophthalmic and Optometric Sciences. 2021;5(4):57-60.
38. Sarzaeim F, Hashemzehi M, Shushtarian SMM, Shojaei A, Naghib J. Flash Visual Evoked Potential as a Suitable Technique to Evaluate the Extent of Injury to Visual Pathway Following Head Trauma. Journal of Ophthalmology and Research. 2022;5(1):0-.
39. Sarzaeim F, Abdolalizadeh S, Shushtarian SMM, Shojaei A. Visual Evoked Potential Findings in Patients using Anti-Seizure Medicine. Journal of Ophthalmology and Research. 2022;5(3):123-6.
40. Ojani F, Shushtarian SMM, Shojaei A, Naghib J. Visual Evoked Potential Findings of Bardet-Biedl Syndrome. Journal of Ophthalmology and Research. 2021;4(3):254-7.
41. Tian Y, Wang Y, Liu Z, Li X. Isolated-check visual evoked potential: a more sensitive tool to detect traumatic optic neuropathy after orbital fracture. Graefe's Archive for Clinical and Experimental Ophthalmology. 2021;259:547-

55.
42. Cornelius C-P, Altenmüller E, Ehrenfeld M. The use of flash visual evoked potentials in the early diagnosis of suspected optic nerve lesions due to craniofacial trauma. Journal of Cranio-Maxillofacial Surgery. 1996;24(1):1-11.
43. Liu S-R, Li M, He F-L, Li Z-K, Fan X-Q. Comprehensive evaluation of visual function in patients with orbital fracture by visual electrophysiology and visual field examination. Journal of Craniofacial Surgery. 2018;29(1):188-92.
44. Tabatabaei SA, Soleimani M, Alizadeh M, Movasat M, Mansoori MR, Alami Z, et al. Predictive value of visual evoked potentials, relative afferent pupillary defect, and orbital fractures in patients with traumatic optic neuropathy. Clinical Ophthalmology. 2011:1021-6.

Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of the present manuscript.