

## Original Article

# Study of Visual Evoked Potentials in Patients Suffering from Exotropia

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## Abstract

**Background:** The present study aims to investigate the visual evoked potentials in patients with exotropia, a type of ocular deviation in which one or both eyes are deflected outwards.

**Material and Methods:** Twenty-five patients with exotropia aged 6-8 years participated in this study as a case group, and twenty-five age- and sex-matched controls were selected as control. VEP was recorded using the Pattern Reversal checkerboard technique for all participants. Latency (msec) and amplitude ( $\mu$ V) of VEP, P100 peak were measured in both groups.

**Results:** The mean amplitude of VEP, P100 peak was 2.92 and 7.84  $\mu$ V in case and control groups, respectively, showing a statistically significant difference ( $P = 0.001$ ). The difference in mean latency of the VEP, P100 peak was not statistically significant between the two groups ( $P = 0.45$ ).

**Conclusion:** Exotropia is a visual disturbance that affects visual evoked potential P100 peak amplitude, whereas the latency of P100 remains intact.

**Keywords:** Exotropia; Visual Evoked Potential.

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## Introduction

Ocular deviation or strabismus is a situation in which the eyes are not aligned. In other words, one eye rotates in a different direction from the other eye. Exotropia is a type of ocular deviation in which one or both eyes are deflected outwards. Various electrophysiological techniques, including Electroretinography (ERG), Electrooculography (EOG), and Visual Evoked Potential (VEP), are used in these patients.

In studies regarding the retina of laborers working in a textile factory in 2018, fifty workers were selected. The workers were exposed to excessive vibration in the factory. The results showed pathological retina changes, measured by electroretinogram<sup>1</sup>. In a recent study by Sarzaeim, F. et al. in 2022, twelve male workers exposed to heavy hand-arm vibration due to their activity with road drilling machines were included. It was concluded that the retina of these laborers was affected due to high vibration, which was reflected in the amplitude of the b wave of electroretinogram (ERG)<sup>2</sup>. In an electrooculogram (EOG) study in 2018, twenty-five patients with a history of amiodarone treatment participated. Results of the present study showed the toxic effects of amiodarone on the retina, which might be detected and followed using EOG and Arden Index (AI)<sup>3</sup>. The comparison of VEP and EOG tests in the early detection of Hydroxychloroquine (HCQ) macular toxicity proved that EOG AI, P100 amplitude, and latency of VEP could all be valuable parameters to detect HCQ retinal toxicity showing no differences between these methods<sup>4</sup>. Among the electrophysiological techniques, VEP was used in the present study to screen the visual pathway in different pathological conditions. In this regard, Shushtarian S.M. et al. (2017) studied fifty laborers at a textile factory.

The factory was equipped with machinery which created excessive vibration showing a delay in VEP, P100 peak latency, which was a clue for the adverse effect of vibration on the visual pathway measured by VEP<sup>5</sup>. In another study, Keramati et al. investigated the effect of Prolactinoma using the VEP technique, which showed VEP changes in these patients. Prolactinoma might have an adverse effect on the visual pathway, especially the optic nerve. Despite normal visual acuity, the field of vision and brain magnetic resonance imaging can be diagnosed by the latency of pattern VEP, P100 peak, which shows the effectiveness of this technique<sup>6</sup>. Many studies have shown the effectiveness of VEP measurement in different pathological conditions<sup>7-11</sup>. One of the pathological condition is exotropia which may change the VEP parameters.

Based on the literature review, the present study was conducted to investigate the probable effect of exotropia on the visual pathway using VEP.

## Material and Methods

This study was approved by the institutional ethics committee, and all subjects signed the informed written consent before entering the study. Twenty-five patients with exotropia participated in this study as a case group. The age of the subjects ranged between 6-8 years. Twenty-five age- and sex-matched controls were selected along with the case group. VEP using Pattern Reversal checkerboard of all study participants was recorded using a Mangoni instrument capable of recording VEP. Conventional electrode attachments were used, and subjects sited three meters from the monitor. Latency (msec) and amplitude ( $\mu$ V) of VEP, P100 peak were measured in both case and control groups. Means and standard

deviations of latency and amplitude of VEP, P100 peak were calculated, and the results were analyzed using SPSS software version 24 (IBM, Armonk, NY, USA). This study has been accepted by ethical committee of Tehran Islamic Azad University of Medical Sciences; ethical code : IR.IAU.PS.REC.1401.214.

## Results

The mean amplitude of VEP, P100 peak was 2.92 and 7.84  $\mu$ V in the case and control groups, respectively, showing a statistically significant difference ( $P = 0.001$ ). However, the difference regarding the mean latency of the VEP, P100 peak was not significant between the case (99.36 msec) and the control groups (98.8 msec) ( $P = 0.45$ ).

Variable	Number of participants	Groups (Mean $\pm$ SD)		P value *
		Control	Case	
Amplitude ( $\mu$ V)	25	7.84 $\pm$ 1.9	2.92 $\pm$ 1.35	0.001
Latency (mSec)	25	98.8 $\pm$ 2.82	99.36 $\pm$ 2.56	0.45

\*Based on Mann-Whitney Test

## Discussion

The present study studied 25 patients aged between 6-8 years with exotropia and 25 age- and sex-matched controls. The mean amplitude of VEP Pattern-Reversal, P100 peak of the affected eye of the case group was significantly less than the amplitude of P100 of the control group. However, the mean latency difference of the VEP, P100 peak was not significant between the case and the control group. According to previous studies, the depression of the VEP amplitude correlates with visual acuity and is associated

with the degree of atrophy<sup>12</sup>.

Limited electrophysiological studies have been conducted on ocular deviation. In this regard, studies have been conducted on heterophoria patients to evaluate the effect of prism-induced heterophoria, including esophoria and exophoria, on binocular visually evoked potentials [BVEP]. It was concluded that heterophoria significantly causes an increase in latency of BVEP, P100 and a decrease in amplitude of the P100 peak [ $P < 0.001$ ]. The result of their study is consistent with the present study's findings regarding the amplitude of VEP, P100 and inconsistent in terms of the latency of VEP, P100 peak. The observed difference may have been caused due to using BVEP in their study and monocular VEP in the present study<sup>13</sup>. Leguire et al. proposed that strabismus causes a significant decline in the amplitude of binocular visual evoked potential<sup>14</sup>, which supports the result of the present study. In another study, Heravian et al. induced fixation disparity by negative lenses and showed that it has no effect on the latency of BVEP but reduces the wave amplitude<sup>15</sup>. Giuseppe et al. reported no decrease in the amplitude of the binocular VEP<sup>16</sup>, which contradicts the present study's findings; however, it is reported that the amplitude of VEP, P100 response is less informative<sup>17</sup>. In fact, there are few references in this regard so the result of the present study may be supported by the above-limited references and how ever the consistency between mentioned references may be a good reason for the result of the present work.

## Conclusion

Exotropia is a visual disturbance affecting visual evoked potential P100 peak amplitude, whereas the peak latency remains intact.

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**References**

1. 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.
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. Tajik F, Shushtarian SMM. Electrooculographic and Electroretinographic Changes among Patients Undergoing Treatment with Amiodarone. *Journal of Ophthalmic and Optometric Sciences*. 2018;2(4):7-11.
4. Allahdady F, Aghazadeh Amiri M, Shushtarian M, Tabatabaee S, Sahraei F, Shojaei Baghini 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 Volume*. 2016;1(1).
5. 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.
6. 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.
7. 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.
8. Sarzaeim F, Hashemzahi 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;5:20-3.
9. Sarzaeim F, Hashemzahi M, Shushtarian SMM, Shojaei A. Visual Evoked Potential Findings in Road Drilling Machine laborers. *Journal of Ophthalmology and Research*. 2022;5:43-7.
10. Shushtarian SMM, Naser M, Adhami-Moghadam F, 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*. 2017;1(4):36-9.
11. 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.
12. Bähr KHaM. Optic nerve: Optic neuritis. *Curated Ref Collect Neurosci Biobehav Psychol*. 2015:205-9.
13. Shushtarian S, Norouzi A, editors. Effect of prism induced heterophoria on binocular visual evoked potential. 4th European Conference of the International Federation for Medical and Biological Engineering; 2009: Springer.
14. Leguire L, Rogers G, Bremer D. Visual-evoked response binocular summation in normal and strabismic infants. Defining the critical period. *Investigative ophthalmology & visual science*. 1991;32(1):126-33.
15. Heravian-Shandiz J, Douthwaite W,

Jenkins T. Effect of induced fixation disparity by negative lenses on the visually evoked potential wave. *Ophthalmic and Physiological Optics*. 1993;13(3):295-8.

16. Giuseppe N, Andrea F. Binocular interaction in visual-evoked responses: summation, facilitation and inhibition in a clinical study of binocular vision. *Ophthalmic research*. 1983;15(5):261-4.

17. Creel DJ. Visually evoked potentials. *Handbook of clinical neurology*. 2019;160:501-22.

#### **Footnotes and Financial Disclosures**

##### **Conflict of interest:**

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