



A STUDY TO ASSESS THE USEFULNESS OF VISUAL EVOKED POTENTIAL [VEP] IN TRAUMATIC OPTIC NEUROPATHY

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ABSTRACT

INTRODUCTION: Traumatic Optic Neuropathy (TON) is a devastating potential complication of closed head injury. Indirect traumatic optic neuropathy is seen in up to 5% of closed head trauma in Indian population. The diagnosis of TON is often missed in emergency room unless viewed with a high index of suspicion in patients with unilateral/bilateral Periorbital Ecchymosis. Visual evoked Potential (VEP) can be helpful to document the presence of TON in unresponsive patients or in cases with concomitant ocular injuries. Patients can also be followed with serial VEP examinations to document recovery of function when clinical parameters are equivocal.

AIM: To evaluate the usefulness of VEP in prognosticating the outcome in Traumatic Optic Neuropathy and to analyze the clinical parameters useful in predicting the final visual outcome.

METHODOLOGY: This study was conducted at the Institute of Neurology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai over a 3 year period. 65 patients of closed head injury with indirect traumatic optic neuropathy were enrolled in the study. Patients were subjected to complete physical examination including tests for visual acuity and Swinging torch light test to detect Relative Afferent Pupillary Defect (RAPD). CT scan of the brain and orbits were done. Visual Evoked Potentials were recorded using the Checker-Board pattern Full-field stimulation method. All patients received intravenous methylprednisolone 1gm daily in divided doses for three consecutive days. Results were subjected to Student's t test and Chi-square test and their prognostic significances were analysed.

RESULTS AND CONCLUSION: 44 patients in the study with persistent absent VEPs had no visual recovery till end of 4 to 6 months. 11 out of 65 patients had improvement in the waveforms over 3 weeks and consequently, improvement in vision at the end of second month. Among clinical features, RAPD grading on admission was predictive of poor visual outcome. Among imaging findings, posterior ethmoid hemmosinus is found to be a negative prognostic sign in patients affected by traumatic optic neuropathy. Thus the present study concludes that VEP can be an useful tool to prognosticate visual outcome in patients with traumatic optic neuropathy.

KEYWORDS : Visual Evoked Potential, Traumatic Optic Neuropathy

INTRODUCTION

Traumatic Optic Neuropathy (TON) is a devastating potential complication of closed head injury. Traumatic optic neuropathy is divided into direct and indirect injuries. Direct injuries occur when an object penetrates the orbit and damages the optic nerve. Indirect TON is a closed injury produced by force imparted to the skull and transmitted into the optic nerve. Some may also require that there be no other evidence of ocular injury¹. Generally, direct injuries have a prognosis that is worse than indirect ION². Indirect traumatic optic neuropathy is seen in up to 5% of closed head trauma in Indian population. The diagnosis of TON is often missed in emergency room unless viewed with a high index of suspicion in patients with unilateral/bilateral periorbital ecchymosis. Visual evoked Potential (VEP) can be helpful to document the presence of TON in unresponsive patients or in cases with concomitant ocular injuries. Patients can also be followed with serial VEP examinations to document recovery of function when clinical parameters are equivocal.

AIM: To Evaluate the Usefulness of Visual Evoked Potentials in Traumatic Optic Neuropathy and to analyze the clinical parameters useful in predicting the final visual outcome.

MATERIALS AND METHODS

Sixty-five patients of closed head injury with indirect traumatic optic neuropathy admitted in the emergency trauma ward in Government General Hospital were studied over a period of three years at the Institute of Neurology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai. Detailed proforma was formulated for each patient and master chart was prepared. The statistical significance of Mode of Injury, Age, Relative afferent pupillary defect (RAPD) Grading, Visual evoked potential (VEP) waveforms, and Posterior ethmoid hemmosinus in Computed Tomography (CT) of the Orbit with that of Final Visual outcome was calculated by Student's t-test and Chi-square test and their Prognostic significance was analyzed. Statistical calculation was done using SPSS software.

INCLUSION CRITERIA: Subnormal Visual acuity, Visual field defects, Relative Afferent Pupillary Defect (RAPD), Patients with Glasgow Coma Score- 15/15, Cooperative patients, Periorbital Ecchymosis.

EXCLUSION CRITERIA: Open globe injury, Retinal detachment, Vitreous hemorrhage, Unconscious / uncooperative patients, Obvious local eye deformities.

The diagnostic criteria for indirect traumatic optic neuropathy were decreased or total loss of vision following closed head injury with various grades of RAPD at presentation. The RAPD grading proposed by Raymond A. Bell et al³ was followed. Detailed clinical history, including mode of injury, treatment received elsewhere for trauma and time of onset of visual impairment, preexisting ocular condition were recorded. Conventional ocular examination and neuro-ophthalmological evaluation with special emphasis on visual acuity, color vision, pupillary size, direct, consensual and accommodative pupillary reaction, and swing flash test and RAPD grading. Before diagnosis of posterior traumatic indirect optic neuropathy, fictitious amblyopia, previously undiagnosed ocular pathology and any neuropathology were excluded.

Investigations included are recording of VEP, visual field, CT orbit. All patients underwent visual evoked potential using pattern reversal method on first day of admission, at the end of first week and at the end of third week.

The methodology of VEP: Using Checker-Board pattern Full-field Stimulation method, VEP was done in all patients. For VEP, standard disc EEG electrodes were used. After the preparation of the scalp, the recording electrode is placed at O_z using conducting jelly. The reference is placed at Fp_z or 12 cm above nasion. The ground electrode is placed at the vertex, i.e. at C_z. The electrode impedance was kept below 5k. VEP was done using standard disc EEG electrodes. The recording electrode is placed at O_z. The reference is placed at Fp_z or 12 cm above nasion, the ground electrode is placed at the vertex, i.e. at C_z.

An amplification ranging between 20,000 and 100,000 was used to record pattern shift visual evoked potential (PSVEP). The filter setting was kept constant. Sweep duration was between 250-500ms. After averaging of 300 waveforms, average P₁₀₀ latency in milliseconds and N₇₅ peak in micro volts was recorded. VEP was recorded in both involved and normal eyes. P₁₀₀ latency and P₁₀₀-N₇₅ amplitude was calculated in all these patients. Visual acuity was recorded each time i.e., on admission, at the end of first week, at the end of three weeks and 8 weeks was recorded. Normal VEP consists of P₁₀₀ latency of 90-120ms and N₇₅ peak amplitude is of 9 – 11µV. VEPs of the affected eye showed an extinguished and flat response or abnormal with P₁₀₀ latency > 130- 140ms and N₇₅ peak amplitude < 7 µV.

VEP was done in all patients on day of admission, at the end of first week and at the end of third week. All patients underwent CT brain and orbit with bone windows on admission. All patients with traumatic optic neuropathy (65) underwent treatment with 1gm intravenous methylprednisolone infusion daily for first 3 days from the time of admission. All the patients were followed up periodically every month for a period of at least 3 months after discharge. Visual acuity at their last follow-up using near-vision card was recorded.

Patients with traumatic optic neuropathy as per diagnostic criteria mentioned earlier were broadly classified into two groups:

1. Patients with absent initial VEP.
2. Patients with initial VEP abnormality.

Patients with absent initial VEP were subdivided into 3 groups:

1. No light perception group (NLP).
2. Light perception group (LP).
3. Counting fingers close to face (CFCF) group.

All patients showed evidence of local injury to one or both eyes in the form of periorbital ecchymosis and subconjunctival hemorrhage (raccoon eyes). Bedside assessment of Visual-acuity was done using Rosenbaum pocket near-vision card.

RESULTS

Of the 65 patients, 54 were males and 11 were females. Of 65 Patients in the present study, traumatic optic neuropathy predominantly occurs in males (83.07%).

The most common mode of injury in the present study was road traffic accident (93%). Three patients had fallen from height. One patient was assaulted.

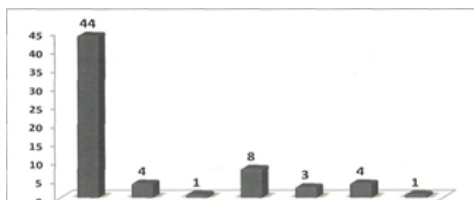
Most of the patients (47 out of 65 patients) in the present study were in the age group - 21-40yrs (72%). 11(23%) patients in this age group had improvement in visual acuity at the end of 8 weeks. Five patients had initial abnormal VEP waveforms. 4 Patients developed abnormal VEP waveforms at the end of first and third week. 3 patients had VEP waveforms only at the end of third week. 36 patients in this age group (77%) had no VEP waveforms even at the end of third week. They had no visual improvement till the time of last follow up. The prognostic significance of Age and Final Visual Outcome was statistically analyzed and found to be insignificant.

Table 1 Age Vs visual outcome

AGE	OUTCOME		Total
	Improved	Not improved	
<20	0	7	7
21-40	10	37	47
41-60	1	8	9
>60	0	2	2

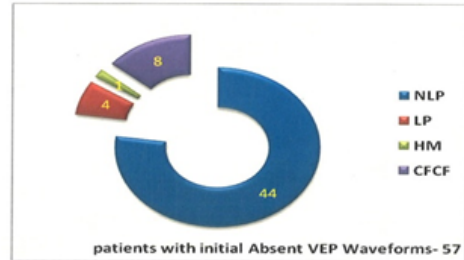
INITIAL VISUAL ACUITY: Visual acuity ranged from no perception of light in 44(68%) patients to 20/40 in one (2%) patient as shown in Figure-1

Fig.1 INITIAL VISUAL ACUITY



CT ORBIT IMAGING: Most of the patients 44 (62%) revealed orbital wall fracture in HRCT imaging. 23(35%) patients showed posterior ethmoid hem sinus on CT imaging. Two patients (3%) had sphenoid hem sinus. Initial VEP was absent in 57 patients on admission. In 8 patients, initial VEP on admission were abnormal. Among the 57 patients who had absent initial VEP, 44 patients had no initial light perception (NLP). 4 patients had only perception of light (LP). 1 Patient was able to appreciate only hand movements (HM). 8 patients were able to count the fingers close to face (CFCF).

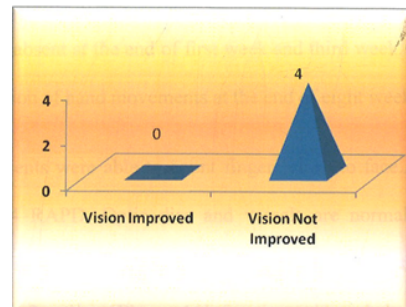
Fig.2 - Visual acuity in patients with Absent VEP



VEP were persistently absent both at end of first and third week in patients with no Initial Light Perception. All 44 patients had grade 5 RAPD according to Bell's classification. Optic disc and Vessels are normal in all these patients. CT orbit showed posterior ethmoid hem sinus in 16 patients in this group. 34 patients had orbital wall fracture (medial/lateral/orbital roof). 18 patients had both orbital wall fracture and posterior ethmoid hem sinus. 2 patients had lesser wing of sphenoid bone and optic strut fracture. [Figure 3] Their visual acuity was also did not improve at the end of 8 weeks. All these 44 patients with No Initial Light perception had no Visual Recovery and their VEPs were not obtained till the end of three weeks.

4 patients had only light perception. These 4 patients had persistent absent VEP waveforms at the end of first and third week. All 4 patients had grade 4 RAPD on examination. They did not show any improvement in visual acuity at the end of 8 weeks. [Figure-4] Optic disc and vessels were normal in all these patients. Of these 4 patients, 2 patients had lesser wing of sphenoid bone fracture with hem sinus. 2 patients showed medial wall of orbit fracture and posterior ethmoid hem sinus.

Fig.4 Visual Outcome in Patients with initial light perception

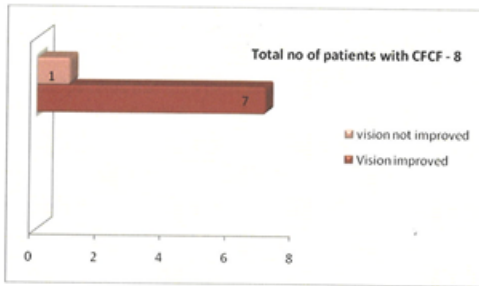


One patient was able to perceive only hand movements with both eyes tested individually. This patient had grade 4 relative afferent pupillary defect. CT orbit showed bilateral posterior ethmoid hem sinus and medial orbital wall fracture. VEP were absent on admission, and persistently absent at the end of first week and third week. Visual acuity was perception of hand movements at the end of eight weeks.

8 patients were able to count fingers close to face. All 8 patients had grade 4 RAPD. Optic disc and vessels were normal in all these patients. CT showed orbital wall fracture in 3 patients, posterior ethmoid hem sinus in 2 patients. 5 patients showed abnormal VEP at the end of first and third week. All these 5 patients showed improvement in visual acuity (20/400 - 3, 20/200-2). The improved visual acuity remained the same at the end of 8 weeks. Of these 8 patients, 2 patients showed abnormal VEP at the end of third week. Both the patients had improved visual acuity (20/200-1, 20/400-1). The visual acuity remained the same at the end of 8 weeks. Both of them showed orbital wall fractures

on imaging. One patient persistently had no VEP at the end of first and third week. He had no improvement in vision at the end of 8 weeks. CT Orbit showed posterior ethmoid hem sinus. Thus, Seven out of eight patients had improvement in vision at the end of second month.

Fig.5 Visual outcome in patients with CFCF



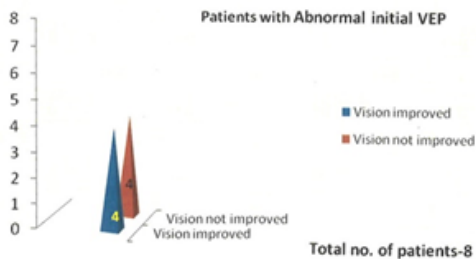
Statistical significance correlating VEP in Patients with CFCF vision and Final Visual Outcome was analysed using Student's t test. VEP was useful in predicting Visual Outcome and prognosticating visual recovery(P value-0.0002). [Table 2]

Table 2 Student's t-Test

	Paired Differences				T	Df	P-Value	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower				Upper
Paired FCF	-.88	.354	.125	-1.17	-.58	-7.000	7	.0002

Of the 65 patients with traumatic optic neuropathy, 8 patients had abnormal initial VEP. Four Patients had Improvement in Vision. Another four patients had no Visual recovery. [Figure-6]

Fig.6 Visual Outcome in Patients with abnormal initial VEP



4 of these 8 patients developed normal VEP at the end of 3 weeks. Correspondingly, visual acuity also improved. They had grade 2 RAPD. Initially all 4 Patients had 20/200 in the involved eye. At the end of 3 week, vision improved to 20/50. Optic disc and vessels are normal in all these 4 Patients. CT Orbit showed orbital wall fracture in three patients. The other patient did not reveal abnormality on imaging. Four out of these 8 patients showed persistent abnormal VEP till the end of 3 week. Visual acuity was not improved in these patients. All of these 4 patients showed grade 3 RAPD in the involved eye. Optic disc and vessels are normal in all these patients. CT orbit revealed posterior ethmoid hem sinus in 3 patients. The other one had medial orbital wall fracture on imaging.

The correlation of VEP and Final Visual outcome in Patients with subnormal Visual Acuity was found not significant (P value-0.065).

Of these 65 patients, 3 patients had bilateral traumatic optic neuropathy. Two patients with bilateral traumatic optic neuropathy had persistently absent VEP waveforms at the end of first and third week. Both the patients had grade 5 RAPD, normal fundus examination, posterior ethmoid hem sinus in CT orbit. Optic disc and vessels are normal in all these patients.

One patient was able to count fingers close to face in both eyes. Both the eyes showed no initial VEP on admission. Subsequently Right eye developed abnormal VEP at the end of third week. Left eye showed

normal VEP waveforms at the end of third week.

All 65 Patients received Intravenous Methyl Prednisolone 1gm daily in divided doses for three consecutive days after admission. 11 out of 65 Patients showed evidence of Visual recovery in the form of improved VEP and improved visual acuity. Statistical analysis was done comparing treatment of TON with steroids and final visual outcome using chi-square test. Treatment with steroids did not influence the outcome (P value -0.653).

DISCUSSION

Traumatic Optic Nerve Injury is a common association with Closed Head injury, which adds to the morbidity. Nevertheless it is important as it could result in permanent visual impairment/loss. A few large series of optic nerve injury are reported in the literature. The present study is a small prospective, nonrandomized study consisting of sixty-five patients with Traumatic Optic Neuropathy.

Road Traffic Accident (RTA) is the most common mode of injury in this study, 61 patients (83%) suffered RTA. This correlates with the values quoted in the literature Mahapatra et al. In the present study, the mode of injury did not influence the Final Visual Outcome. Mode of injury is not statistically significant (P value - 0.648) to be causally related to final visual outcome. Age, Mode of injury did not contribute to the final visual outcome similar to the observation made by Harsha Bhattacharjee et al, 2008.

Posterior indirect traumatic optic neuropathy occurs predominantly in young males but can occur in both sexes and all ages. In the present study a similar finding was observed where mostly males were affected.

Among clinical features, RAPD grading on admission was predictive of Poor visual outcome (P value- 0.000). Most of the patients in present study (48 out of 65 patients) showed grade 5 RAPD on admission. These patients had poor vision (no light perception or light perception) on admission. They had persistent Absent VEP waveforms at all three intervals. These 48 patients had no improvement in vision at the end of second month.

Five Patients with grade 4 RAPD developed Abnormal VEP by the end of first and third week, consequent Visual Improvement. Four Patients with grade 3 RAPD and abnormal VEP had Visual Recovery later at the end of second month. Two patients with grade 2 RAPD had initial abnormal VEP and subsequently developed normal VEP at the end of third week. These patients had improvement in vision.

The present study shows RAPD grading was found to be significant in relation to final visual outcome (P Value - 0.00) as proposed by Alford et al high grade RAPD on admission was predictive of poor visual prognosis. In a study by Harsha Bhattacharjee et al, RAPD (P=0.365) was not found significant in reference to final visual outcome. But in the present study, RAPD grading was found to be significant in relation to final visual outcome (P Value - 0.00).

Among imaging findings, 34 patients with posterior ethmoid air cell hem sinus had absent VEP and poor final visual outcome. This was statistically significant (P value=0.002). From the present study, posterior ethmoid hem sinus is found to be a negative prognostic sign in patients affected by traumatic optic neuropathy. The present study finding is supported by carta et al. The present Study also supports the views expressed by Fujitani et al and Lessel5 in that associated injuries and fractures do not influence the outcome.

44 of the 65 cases with absent VEP at initial presentation had poor final vision. This shows the usefulness of absent VEP in predicting a poor visual outcome as reported by Nau et al.

All four patients who had initial light perception had persistently absent VEPs at all three intervals. On follow up, no patients had vision recovery. Among Eight Patients who had visual acuity of CFCF, 7 patients had visual improvement. 5 patients showed abnormal VEPs at the end of first and third week. 2 patients developed abnormal VEP at the end of third week. This improvement of negative VEP to abnormal VEP was more predictive of visual improvement. This was statistically significant (P value=0.0002) in present study using Student's t test.

Among 8 Patients with abnormal Initial VEP, four Patients developed

normal VEP waveforms at the end of third week. Consequently, these Patients had improved vision at the end of second month. Thus, Improvement of abnormal to normal VEPs was indicative of visual recovery. Though statistically not significant in the present study, more volume of patients may be needed to show the predictive value of VEP in determining the visual outcome.

Two patients who had no initial light perception and hand movements in both eyes respectively showed no improvement in vision at the end of second month. Thus VEP has been useful to predict the poor visual outcome in these patients. One patient had transition of absent VEP waveforms to abnormal waveform in right eye and to normal VEP waveform in the left eye. Visual acuity was 20/200 in the right eye at the end of second month. In the Left eye Visual acuity was 20/50 at the end of second month. Recovery of VEP from no response to abnormal wave or abnormal wave to normal VEP was the indicator of relatively good visual prognosis in this patient. Reduced amplitude in some cases and increased latency in others suggest that ischemic/compressive and subsequent demyelization may be the underlying pathology responsible for indirect trauma to the optic nerve.

All 65 Patients received Intravenous Methyl Prednisolone 1gm daily in divided doses for three consecutive days after admission. 11 out of 65 Patients showed evidence of Visual recovery in the form of improved VEP and improved visual acuity. Treatment with steroids did not influence the outcome (P value - 0.653). This is similar to suggestions given by Levin et al.

CONCLUSION

The present Study of 65 Patients with closed Head Injury with Traumatic Optic Neuropathy lead to following Conclusions:

1. Recovery of VEP from no response to abnormal wave or abnormal wave to normal VEP was indicator of relatively good visual prognosis. Eleven out of 65 Patients in the present Study had improvement in VEP waveforms over three weeks and consequently, improvement in vision at the end of second month. Though statistically not significant in the present study, more volume of patients may be needed to show the predictive value of VEP in determining the Visual Outcome.
2. Absent VEP is useful in predicting a Poor Visual Outcome. All 44 patients in the present Study with persistent Absent VEPs had no Visual Recovery till end of 4-6 months. Thus the present study concludes that VEP was the single most important factor determining the Outcome. It proved the role of both positive and absent VEP waves in predicting the Outcome.
3. Among clinical features, RAPD grading on admission was predictive of poor visual outcome. Among imaging findings, Posterior ethmoidal sinusitis is found to be a negative prognostic sign in patients affected by traumatic optic neuropathy. Age, mode of injury did not contribute to the final visual outcome.
4. Treatment with Steroids did not influence the visual outcome.

LIMITATIONS OF THE STUDY

1. Small volume of patients.
2. There were no cases with compressive lesion in the study and hence the role of surgical decompression could not be evaluated.
3. In the present study of VEP, use of Flash Light Method would have thrown better light.

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