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Original Research Article

Role of visual evoked potential (VEP) in indirect traumatic optic nerve (ITON) injuries and assessment of the visual outcome

D Sangeetha[1], Saravanasankar P[1]*, S Sangeetha[1]

[1]*Dept. of Ophthalmology, Government Rajaji Medical College and Hospital, Madurai, Tamil Nadu, India*

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ABSTRACT

Objective: To demonstrate the critical function of Visually Evoked Potential (VEP) in the prompt detection of indirect optic neuropathy.

Materials and Methods: 60 patients suspected of having traumatic optic nerve injury underwent VEP testing in < eight hours of traumatic experience.

Results: Baseline visual acuity was revealed to be the most imperative prognosticator of eventual visual outcome. The VEP was instrumental in the primary detection as well as validation of ITON. Additionally, VEP aided in predicting prognosis and follow-up for patients with IITON. Visual recovery is impossible in the absence of recordable VEP waves. The manifestation of orbital fractures wasn't associated with a preliminary or ultimate visual perception decrease. Patients who present < 8 hours following ITON with normal initial visual acuity, VEP alterations, and lower RAPD grades may have a greater chance of recovering final visual perception when treated with an instantaneous high steroid dosage.

Conclusion: The above-mentioned prognostic markers in patients with ITON may be beneficial in predicting visual prognosis and determining the need for surgical therapy in patients who experience vision loss following head trauma.

1. Introduction

The optic nerve (ON) is our most critical cranial nerve. The functional integrity of the eye and the presence of diseases of the optic nerve are primarily assessed using four tests. Key funduscopic results are included with the descriptions of this examinations.[1] The ON is susceptible to indirect besides direct trauma, impairing vision. Optic nerve injuries occur as a common complication of a car crash or a fall instigated by a head injury.[2] Optic nerve damage occurs in a noteworthy percent of closed head injuries. Added fatal injuries can interrupt the identification of ON injury. Therefore, the examination of acutely injured patients is difficult.[3]

This visual injury instigated by acute impairment to the ON is called 'traumatic optic neuropathy (TON)'. TON is a category of 'optic neuropathy caused by head trauma. In the case of craniofacial fractures, TON is more common.[4,5] The most common damage resulting in blindness is either the forehead or the supraorbital ridge, with the temporal region being less prevalent. The hit is usually severe, resulting in unconsciousness, yet the impairment can also be minor, leaving the patient bewildered. The clinical sequence of events is typical: following a head injury, the patient regains consciousness and realizes that one eye is injured or missing. The ocular examination is initially normal rather than a comparative or complete afferent pupillary abnormality. Many different types of visual field abnormalities can emerge. After 4–6 weeks, ocular atrophy begins.[3]

* *Corresponding author*.
E-mail address: shravana76@yahoo.com (Saravanasankar P).

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A severe form of traumatic injury to the brain and brainstem can ground irretrievable vision loss.[6] Visual impairment is not well understood due to the widespread impacts of traumatic brain injury. The 'intra-canalicular' part of the ON is most susceptible to traumatic effects such as compression besides ischemia. Sharpness, field, and colour vision can all be affected by TON.[7] Direct TON (DTON) refers to when the nerve is directly wounded by any entity that infiltrates the orbit, damaging the ON. ITON is detected when nerve damage occurs as a result of a trauma that is non-infiltrating. A relatively more focus is directed towards the management of ITON rather than DTON owing to its higher recovery rate.[2]

ITON is an optic nerve lesion caused by a remote impact. The mechanism of harm is unknown, as are no proper preventative, mitigation, and therapy techniques. Apart from military ballistic or explosion injury, most data on this illness comes from civilian patients who have suffered blunted damages, for instance, sporting or transportation based concussions. Developing strong online information systems to identify patients with ITON and track their results and invivo animal and simulated human replicas to explore damage processes and potential therapeutics will likely be required. ITON differentiates from DTON. ITON is an optic nerve and canal afferent pupillary dysfunction. Normal acute slit-lamp examination, MRI, and CT scan of the afflicted area can all detect ITON.[6]

With a recovery rate of only around 50%, ITON is regarded as a substantial cause of permanent vision loss. However, regain of vision within a short period of time post-trauma was not permanent and often associated with a progressive decline of visual performances in the long term. Presently, there is no reputable antidote for this illness, and its appropriate management is debated. It is also documented that neither management strategies such as corticosteroid therapy nor optic canal decompression institute a good customary for treating ITON.[8] On the other hand, ITON cases that displayed no signs of progress in the initial stage have been observed with vision gain by treatments.[9] Hence the subsequent study evaluated the role and outcome of visual evoked potential in ITON.

2. Materials and Methods

This prospective observational study was conducted in the Department of Ophthalmology at Madurai Medical College from January 2017 to June 2017. Patients are selected among those admitted to the trauma ward with a head injury. The ophthalmic examination is done, and those diagnosed with indirect optic nerve injuries were selected for study based on inclusion and exclusion criteria.

2.1. Inclusion criteria

Patients with head injury irrespective of initial visual acuity at the time of presentation. Age more than 20 years in both gender. Diagnosis of indirect traumatic optic nerve injury within 8-12 hours of trauma. Normal or near-normal field of vision

2.2. Exclusion criteria

Rupture globe, history of loss of consciousness for more than 24 hours. Patients with concurrent traumatic brain parenchymal injury. History of seizures History of underlying neurological disorders, neurotoxic drugs. History of diabetes mellitus, systemic hypertension, cardiac disorders, psychiatric illness, alcoholism. Mature cataract, glaucoma and other ocular optic nerve disc diseases. Patients with congenital ocular diseases (Eg.Retinitis pigmentosa). Optic nerve avulsion Optic neuritis (all types), optic atrophy, ischemic optic neuropathy. Past history of eye surgery with retro bulbar block. Prior neurosurgical intervention Patients not willing for regular follow-up.

A forthcoming observational analysis was conducted to perceive the sub-clinical outcomes in ITON patients by means of VEP then to commence subsequent management practices for enhanced absolute visual outcome.

2.3. Procedure

Patients satisfying both inclusion and exclusion criteria are selected and detailed on study methods. Snellen's chart was employed to note down initial visual perception post consent. Torchlight, besides the slit lamp bio-microscopy method, was used to inspect the anterior segment. Pupilloscope was utilized in the investigation of pupils. Patients were analyzed in sitting positions for VEP. A pseudo-isochromatic Ishihara's colour vision chart was applied to test colour vision, and the perception field was analyzed by Bjerrum's method. Tension was checked by means of a Schiotz's tonometer, and fundoscopy was performed either by direct ophthalmoscope or +90D lens with the slit lamp. Management strategy using drugs was adopted.

The data gathered on all of the randomly selected samples were recorded. The data were analyzed using the SPSS 16 software and the Sigma stat 3.5 edition. The mean, standard deviation, and 'p-value were determined using this software using the student t-test, Chi-square test, and person correlation, with a p-value of 0.05 considered significant.

3. Results

The study was conducted on 60 patients diagnosed with ITON and fell under the inclusion mentioned above category. Patients were divided into 5 age groups (Table 1). The higher number of patients belonged to the age group 31-

35, 26-30 and <25 years of age. A lower number of patients were found in those>35 years of age. With respect to the gender-based analysis of the prevalence of ITON, males were predominant (75%) compared to females (25%). Also, the right eye was found to be the most affected, 73.3%.

Table 1: Distribution of patient characteristics

Patient characteristics		No.of cases	Percentage
Age	< 25	12	20
	26 - 30	19	31.7
	31 - 35	21	35
	> 35	8	13.3
Gender	Male	45	75
	Female	15	25
Eye	Right	44	73.3
	Left	16	26.7

Table 2: Distribution of nature of trauma

Nature of Trauma	No. of cases	Percentage
Assault	7	11.7
Accident fall	5	8.3
Bike accident	8	13.3
Car accident	4	6.7
Motor accident	2	3.3
Fall from height	10	16.7
RTA	16	26.7
Trauma with pipe	4	6.7
Trauma with stone	4	6.7
Total	60	100

The most common cause of traumatic incidence was accounted for road traffic accidents (RTA), 26.7%, followed by fall from height (16.7%), bike accident (13.3%), assault (11.7%) and accident fall (8.3%). In a notable number of patients, car accidents and trauma caused by pipe and stone were also noted (6.7% each). Only 2 patients were affected by ITON because of motor accidents (Table 2).

Table 3: Distribution of time of presentation

Time of presentation	No. of cases	Percentage
< 6	27	45
6.1 to 12	26	43.3
> 12.1	7	11.7
Total	60	100

Patient presentation time was also observed. Most of the patients presented within 6 (45%) and after 6 to 12 hours of trauma (43.3%). However, 11.7% of patients reported more than 12 hours of post-traumatic experience (Table 3). RAPD was detected as 3+ in the maximum number of patients (28) followed by 2+ and 4+in 22 and 10 patients, respectively (Table 4).

CT scan revealed damage to the medial orbital wall (31.7%), orbital floor (10%) and haemorrhage (6.7%), as well as Zygomatic (5%). No fractures were associated with over 46.7% of the patients (Table 5).

Table 4: Distribution of RAPD

RAPD	No. of cases	Percentage
2 +	22	36.7
3 +	28	46.7
4 +	10	16.7

Table 5: Distribution of CT-scan findings

CT scan findings	No.of cases	Percentage
Medial orbital wall #	19	31.7
Orbital floor #	6	10
Orbital haemorrhage	4	6.7
Zygomatic #	3	5
No fracture	28	46.7

Table 6: istribution of visually evoked potential

VEP	No. of cases	Percentage
Reduction in amplitude in P2	6	10
Reduction in amplitude and delay in P2	14	23.3
Severe delay	15	25
Reduction In Amplitude and severe delay in P2	15	25
Absence of VEP response	10	16.7
Total	60	100

In the follow-up study, a reduction in amplitude in P2 was found in 6 patients. Decrease in amplitude and both delays and severe delay in P2 were observed in 23.3 and 25% of patients. In 15 patients, there was a severe delay in VEP, while in 10 patients, there was no response to VEP (Table 6).

Table 7: Distribution of visual acuity

Visual acuity	Initial visual acuity (No. of patients)	Final visual acuity (No. of patients)
NLP	13	11
HM	24	6
CFCF	4	8
3/60	4	9
6/60	7	14
6/36	8	6
6/9	0	6

At the time of presentation, 24 patients were recorded with HM, and 13 were found to have NLP. CFCF was observed in 4 patients. Patients with visual acuity of 3/60, 6/60 and 6/36 were observed in 4, 7 and 8 patients, respectively (Table 7). No patients were observed with 6/9 visual acuity at the time of presentation. Post-treatment, there was a significant reduction in HM from 24 to 6. There

was also a reduction in visual acuity values of NLP and 6/36 to 11 and 6, respectively. Visual acuity values increased from 7 to 14 in 6/60, 4 to 8 and 9 in CFCF, and 3/60, respectively. Visual acuity value increased to 6 in 6/9.

Pattern VEP test revealed the reduction in P2 and reduction delay in P2 in 17 patients among 20 diagnosed. Among 40 cases with the reduction in amplitude and severe delay, severe delay and VEP absence, 6 were recorded with a final visual acuity of 20/<150 (chi-square value- 24.75). The initial and final VA values were significantly different ($p < 0.001$). There was a good correlation between RAP and initial VA (-0.88) and between RAPD and final VA (-0.81). There was a very poor correlation between orbital fractures and VA (-0.38).

4. Discussion

ITON begins with optic nerve dysfunction without direct structural or tissue destruction. Therefore, TON should be deliberated in all head associated trauma patients, which is still rare. ITON rises from the shearing of nerve fibres, blood supply stoppage, or subsequent edoema and haemorrhage from shearing or transection of optic nerve vessels.[10] However, the degree of clinical manifestations of ITON is associated with the severity of trauma to the eye and the type of injury. Moreover, several reports indicate the ineffectiveness of treatments on vision regains in the case of ITON through CT scan evaluations. Henceforward the contemporary study was conceded out to evaluate the significance besides the consequence of visual induced potential in ITON among 60 patients diagnosed with ITON of trauma ward by performing an ophthalmic evaluation.

The age distribution of patients ranged from 19-2, with a mean age of 30.2 years. The presence of ITON was mainly diagnosed among the age group of 31-35. ITON was found to occur predominantly in males. The gender ratio of male: female was found to be 3:1. In the previous study[10] the gender ratio was also reported to be 4:1 with a higher proportion of male ITON patients. In a likely study conducted by Tabatabaei et al.,[10] patients with ITON mainly were males with a mean age of 18.2 years. A similar percentage of males with ITON were recorded in both studies (75%). In a study conducted by Carta et al.,[9] among the number of cases included for study in ITON, the age group predominantly belonged to those below 40 years.

According to a previous report, among the patients admitted for facial fracture treatment, a considerable number of them reported blindness due to ITON in at least one eye.[11] In our present study, the laterality of ITON patients has deviated more towards the right eye than the left. In our analysis, the laterality of ITON occurrence between both eyes was significantly different ($p<0.001$). The largest occurrence of ITON in the right eye was also previously reported by Mohammed et al.[12] Pirouzmand et al.[13] have also registered that TON was found to exist in males predominantly, with a higher number of patients belonging to the median age of 31 years.

The nature of assaults that could reason an ITON is attributed to a closed head injury, particularly a forehead or periorbital smack.[14] Over 9 etiologies of ITON were recorded from the patients in this study. The most significant reason for the development of trauma instigated ITON was road traffic accidents, followed by fall and automobile-related accidents. As per the results of Bhattacharjee et al.,[15] a significant proportion of ITON included in the study was instigated by road traffic accidents in two-wheelers. The previous study[12] correlates assault and car accidents to the etiology of ITON. Assault instigated ITON was found to be recorded as in significant proportion in our current study.

The mean time of presentation of patients in our study was 7.4 hours after trauma. The majority of patients presented themselves within 7 hours of trauma. In our study, 45% of patients presented within 6 days, recording the higher recurrence of presentation time followed by 43.3% of presentation time by patients who fell within 7 to 12 days. The meagre number of patients presented themselves with more than 12 days of post-traumatic experience. A similar patient presentation time was also reported by Mohammed et al.[12] However, the mean presentation time was observed to be 2.7 days, which was almost similar to the presentation time conveyed by Tabatabaei et al.[10]

As an index for detecting variations of eye responses to light perception, the RAPD test was performed and correlated with IVA. The initial visual acuity (IVA) ranged from no light perception (NLP) to 6/36. There was a noble association between RAPD and IVA. All the patients displayed the presence of RAPD that was related to the existence of poor vision.[16] A positive RAPD indicates variations in the afferent route between the two eyes due to retinal or optic nerve illness.[17]

CT is the best and easiest way to detect optic canal fractures, orbital wall fractures, and bleeding in orbit. It can be used to diagnose ITON and as a surgical guidance map. The prognosis is worse in patients with ITON and posterior orbital fractures than those with ITON and anterior orbital fractures, indicating a prognostic significance for CT scan.[18] CT scan of our patients revealed no fracture in a majority of patients. Fractures in the medial orbital wall were present in a noteworthy quantity of patients with the occurrence of fractures in the orbital floor and Zygomatic was also present notably. A similar proportion of fractures in CT scan patients were reported by Mohammed et al.[12] On CT, they reported that 60% of the study group had no evidence of direct TON, 40% had orbital wall fracture with no sign of optic nerve compression. The inference was similar to the findings of our investigation.

In combination with the VEP, the orbital CT scan is critical for detecting optic nerve injuries quickly.[19] Furthermore, based on the study's CT findings, it was

determined that there was no link between the presence of an orbital fracture and the severity of the visual loss. A parallel statement associating the irrelevancy of orbital fracture to vision loss based on CT imaging was reported by Tabatabaei et al.[10]

In a study reported by Lessell,[20] the craniofacial fracture was found in 17 of 33 cases, with seven of those cases having a fracture interconnecting the optic canal. However, neither the occurrence nor the position of the fracture was found to be associated with the severity of the ITON. In an additional study, it was projected that the presence of a posterior rather than anterior orbital fracture on CT imaging was associated with a worse prognosis for the visual outcome; however, the presence of a blow-in or blowout fracture on the CT scan was not found to be associated with a significantly worse visual outcome.[21]

Studies of VEP are considered trustworthy techniques for getting valuable information on whether or not visual function is intact in a given individual. When VEP results are not recordable, visual recovery will probably be impossible.[22] Lesion of the optic nerve in our study was ascertained by estimating VEP. A considerate number of patients in our study was recorded without VEP. An additional record of patients who displayed a delay in P2 is considered an indicator of optic nerve insults. To determine the importance of VEP in the early detection and prognosis of ITON, 60 patients with suspected traumatic optic nerve injury underwent VEP within 8 hours of the event. VEP can detect aberrant cortical activity in the visual system due to a flash or pattern stimulus, which can be seen in several types of optic neuropathy. Although pattern VEPs may be normal, anomalies in a flash VEPs have been recorded in cases of ocular neuritis, disease of the optic nerve sheath, and undiagnosed retinopathy.[22]

Systemic corticosteroids and surgical optic nerve decompression conduct TON, which can be used alone or in combination. Steroids have been utilized pre-, intra-, and postoperatively, both alone and in combination with surgical optic nerve decompression. A course of intravenous methylprednisolone in the extremely high-dose to megadose range is the most widely used steroid regimen in TON.[23] All patients were treated with IV Methyl sulphate regardless of their initial visual acuity. Prednisolone (1g OD/3 days), then oral prednisolone 1 mg/kg body weight/day for 11 days, followed by tapering.

After two weeks, the patient's final visual acuity was tested. 20 Patients with lower P2 amplitude and a lower P2 amplitude besides a delayed P2 had final visual acuity of >6/60. Within two weeks, 15 patients had progressed to a score of >6/12—only 6 of the remaining 30 patients with severe delays improved out of the blue. A score of >6/60 indicates a dismal prognosis. Patients with no wave evoked lower rates of VEP prognosis. The correlations between clinical and VEP limitations disclose a statistically significant positive correlation between final visual acuity and initial VEP findings, as well as a statistically significant positive correlation between final visual acuity and the pattern of VEP waveform. In a similar study, the N2P2 amplitude ratio flanked by the usual and the affected eye directly correlates with the final visual acuity.[12]

Our study ascertains a negative correlation between orbital fracture and initial or final visual acuity. Similarly, several earlier studies also have stated a non-correlative association between orbital fracture and visual acuity.[9,10,24] Therefore, patients who present within 8 hours of ITON with good initial visual acuity, VEP changes, and minor scores of RAPD may have a better chance of recovering absolute visual perception when treated with an instantaneous high dose of steroid therapy, according to our research.

5. Conclusion

Visual Evoked potential is a valuable clinical tool to confirm indirect optic nerve injury and predict the visual prognosis following treatment. RAPD grades showed a correlation with the results of Visual Evoked Potential.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Author biography

D Sangeetha, Assistant Professor

Saravanasankar P, Assistant Professor

S Sangeetha, Assistant Professor

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