



Original Research Article

Reversal of optic nerve function and visual outcome in traumatic optic neuropathy

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ABSTRACT

Introduction: Traumatic optic neuropathy (TON) refers to an acute injury to the optic nerve secondary to ocular trauma. The study was conducted to evaluate the visual outcome in cases of TON and to study reversal of optic nerve function after emergency ophthalmic intervention.

Objectives: To evaluate the visual outcome in cases of TON, study the factors affecting final visual outcome and to evaluate the optic nerve function in cases of TON.

Methodology: The present study was a Prospective observational study, 49 patients presented after ocular trauma in the Department of Ophthalmology, Gandhi Medical College and Associated Hamidia Hospital, Bhopal during January 2018 to June 2019. A detailed history was taken and examination was done. Time since injury was noted and optic nerve functions were assessed using modes such as VEP, perimetry, color vision, contrast sensitivity and presence/absence of RAPD. Participants were subjected to CT scan of head to assess associated injuries. The patients were managed medically by giving 5 doses of IV methylprednisolone for five days with tapering oral tablet prednisolone and observed for 3 months of followup from the initiation of treatment. All the data entered in proforma and results obtained on the basis of variables were discussed.

Results: Most common mode of injury was RTA 68.4%. VEP improved significantly following steroid. Visual recovery was observed in 37.1% patients. The present study observed statistically significant association of final visual outcome was observed with time elapsed between injury and treatment and associated skull/maxilla or orbital bone fractures.

Conclusion: The pattern of visual recovery depends upon the visual acuity at presentation, type of injury, time elapsed between injury and initiation of treatment, associated skull or orbital fractures and patient compliance as better is the visual acuity at presentation, better is the visual recovery.

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1. Introduction

Traumatic Optic Neuropathy following craniofacial injuries was first described by Hippocrates¹. Traumatic optic neuropathy refers to an acute injury to the optic nerve secondary to trauma (blunt or penetrating). It is an uncommon though devastating cause of permanent vision loss following contusive injuries to the head, particularly forehead caused by direct or indirect impact to the optic nerve. The impact transmits a shockwave to the optic canal damaging the optic nerve. Visual loss may be partial or

complete.²

Traumatic optic neuropathy can be classified depending on the site of injury (i.e. optic nerve head, intraorbital, intracanalicular or intracranial) or according to the mode of injury (i.e. direct or indirect). Direct Traumatic optic neuropathy results from anatomical disruption of nerve fibers by penetrating trauma, bony fragments within the canal and nerve sheath hematoma. Indirect injury results from transmission of forces to the nerve from a distant site without disruption of normal tissue structures.³

Patients of traumatic optic neuropathy present with vision loss after blunt or penetrating trauma. Symptoms of Traumatic optic neuropathy usually consist of acute

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unilateral decrease in vision or visual fields. Delayed diagnosis may occur secondary to other injuries related to the trauma such as traumatic brain injury. Such injuries would delay the presentation and thus, the evaluation of any ophthalmologic injury. The history and subjective complaints may be delayed due to the impact of and treatment for other concomitant head injuries or other systemic co-morbidities.⁴

Corticosteroids are the mainstay of treatment in case of Traumatic Optic neuropathy which can be categorized as moderate dose i.e.60-100 mg of oral prednisolone, high dose i.e.1 gm of intravenous methylprednisolone per day or mega dose i.e. 30 mg/kg loading dose of intravenous methylprednisolone followed by 5.4 mg/kg/h for 24 hours.⁵

The present study was undertaken to evaluate the necessity and importance of ophthalmological examination in cases of trauma for the complete diagnosis and its benefit in subsequent management.

2. Objectives

1. To evaluate the visual outcome in cases of traumatic optic neuropathy.
2. To study the factors affecting final visual outcome.
3. To evaluate the optic nerve function in cases of traumatic optic neuropathy.

3. Materials and Methods

Study design: Prospective observational study

Study area: Department of Ophthalmology, Gandhi Medical College and Associated Hamidia Hospital, Bhopal

Study Duration: January 2018 to June 2019.

3.1. Inclusion criteria

1. All cases reporting to Eye OPD, Indoor patients, Emergency/Casualty and referred patients from other departments of Hamidia hospital.
2. All diagnosed cases of ocular trauma with or without head injury.
3. Already diagnosed cases of traumatic optic neuropathy elsewhere.

3.2. Exclusion criteria

1. All other cases of Optic neuropathies such as ischemic neuropathy, Diabetic neuropathy and other ocular manifestations such as Traumatic cataract.
2. Patients not given consent.

All the patients fulfilling the inclusion criteria during the study period were selected and enrolled. The patient were informed and explained about diagnostic procedures to be undertaken to help in determining the extent as well as the severity of the damage caused to the optic nerve. A detailed history regarding their sociodemographic variables, mode of

injury and time of injury was obtained from all the patients. Visual acuity on Snellen's test type chart unaided, with pin hole and checking any type of refractive error was recorded for all the patients. All patients underwent complete ocular examination including Torch Light Examination and Slit Lamp examination. Fundus examination using Direct and Indirect Ophthalmoscope was done depending on the basis of media clarity. Apart from this, optic nerve functions were assessed using VEP, B-Scan Ultrasonography. CT scan of head was also done to rule out associated injuries in all the patients. Automated perimetry to assess the location of any lesion throughout the visual pathway. Blood samples were collected and subjected to RFT, LFT and CBC examinations prior to start of treatment.

Following this, treatment was undertaken as per the standard treatment protocols and prognosis was observed. The treatment protocol includes Pulse Therapy of methylprednisolone i.e.1 gm of intravenous methylprednisolone per day for five days. Other systemic management includes giving methylcobalamin and proper management of associated injuries. The patients were examined daily and followed up for 3 months with final follow-up 3 months from initiation of treatment.

Statistical analysis- The data thus obtained were entered in prescribed Performa and then analyzed statistically. Data was compiled using Ms Excel and analysed using SPSS 20 software. Data was grouped and expressed as frequency and percentage whereas numerical data was expressed as mean and standard deviation. Chi square test was applied to assess the association between proportions whereas difference in mean VEP before and after treatment was analysed using paired t test. P value <0.05 was considered statistically significant.

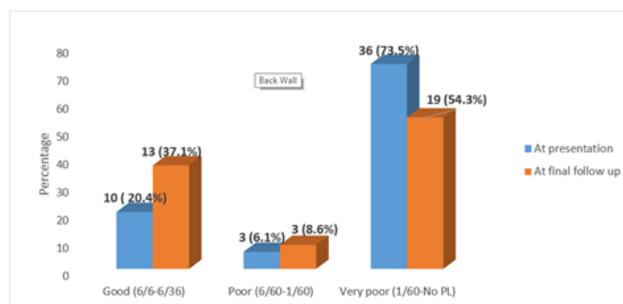


Fig. 1: Distribution according to visual acuity (BCVA)

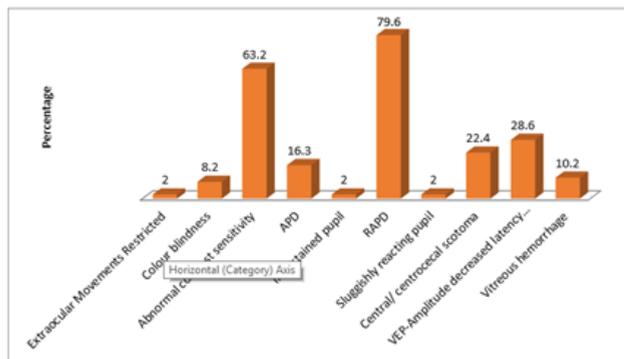
4. Results

The present study enrolled a total of 49 patients of traumatic optic neuropathy fulfilling the inclusion criteria during the study period.

In the present study, out of 49 patients, majority belonged to 26 to 35 years of age group that is 32.9%, followed by 28.5% belonging to 16-25 years. Only 8.2%

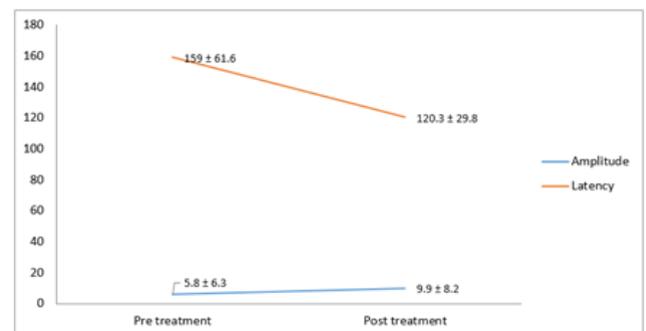
Table 1: Distribution of patients according to baseline variables (n=49)

Baseline variables	Number of patients (n=49)	Percentage (%)	
Age group (Years)	≤15	4	8.2
	16-25	14	28.5
	26-35	16	32.9
	36-45	10	20.4
	>45	5	10.2
Gender	Male	44	89.8
	Female	5	10.2
Occupation	Businessman	2	4.1
	Housewife	4	8.1
	Labour	23	46.9
	Servicemen	4	8.1
	Farmer	4	8.1
	Student	12	24.4
Mode of injury	RTA	34	69.4
	Assault	2	4.1
	Others	2	4.1
Type of injury	Direct	22	44.9
	Indirect	27	55.1
Time lapse between injury and treatment	<24 hours	15	30.6
	24-48 hours	8	16.3
	48-72 hours	4	8.2
	>72 hours	22	44.9
CT scan	Normal	27	55.1
	Lateral orbit bone fracture	3	6.1
	Medial orbit bone fracture	2	4.1
	Orbital roof fracture	2	4.1
	Orbital floor fracture	2	4.1
	Zygomatic bone fracture	4	8.2
Skull bone fracture	9	18.4	

**Fig. 2:** Distribution according to Ocular examination

patients were belonging to the age group of less than 15 years. Maximum patients (89.8%) were males and only 5(10.2%) patients were females. Majority of patients with traumatic optic neuropathy were laboursn (46.9%) followed by students (24.4%). About 8.1% patients each were housewife, servicemen and farmers.

Out of 49 patients, majority of patients that is 34 (69.4%) presented following road traffic accident followed

**Fig. 3:** Distribution according to findings of optic nerve tests

by 11 (22.4%) patients after fall, 2(4.1%) patients after alleged history of assault and 2(4.1%) due to other causes respectively. Of them direct mode of injury was observed in 44.9% whereas in 55.1% patients presented with indirect mode of injury.

Majority of patients presented between 48 to 72 hours following injury (44.9%) followed by 30.6% and 16.3% patients presenting and receiving treatment within <24 hours and 24 to 48 hours respectively. Associated fractures

Table 2: Distribution according to ocular examination

	Ocular findings	Number of patients (n=49)	Percentage (%)
Extraocular muscles	BE WNL	43	89.8
	Movements Restricted	1	2.0
	Patient Not Reported	4	8.2
Color vision	WNL	12	24.5
	Could not be done in affected eye	30	61.2
	Patient not reported	3	6.1
	Red green color blindness	4	8.2
Contrast sensitivity	Normal	15	30.6
	Abnormal	31	63.2
	Patient not reported	3	6.1
RAPD/APD	APD	8	16.3
	Ill Sustained Reacting	1	2.0
	RAPD	39	79.6
	Sluggish	1	2.0
Visual fields	BE WNL	8	16.3
	Central scotoma	6	12.2
	Centrocecal scotoma	5	10.2
	Could not be done in affected eye	25	51.0
	NA	2	4.1
	Patient not reported	3	6.1
VEP	Amplitude decreased latency increased	14	28.6
	BE WNL	1	2.0
	Could not be done in affected eye	23	46.9
	NA	8	16.3
	Patient not reported	3	6.1
B scan	BE WNL	34	69.4
	NA	7	14.3
	Patient not reported	3	6.1
	Resolving vitreous haemorrhage	2	4.1
	Vitreous hemorrhage	1	2.0
	Vitreous hemorrhage with choroidal rupture	2	4.1

Table 3: Association of various factors with final visual outcome (n=35)

Factors affecting final visual outcome	Visual acuity (BCVA) at final follow up (3 months)			P value
	6/6-6/36	6/60-1/60	<1/60	
Age group (Years)	≤15	3	0	0.09
	16-25	6	0	
	26-35	2	1	
	36-45	1	1	
	>45	1	1	
Gender	Male	11	2	0.31
	Female	2	1	
	RTA	11	2	
Mode of Injury	Assault	1	1	0.31
	Others	1	0	
Time between injury and treatment	<24 hours	9	1	0.02
	>24 hours	4	2	
	Normal	11	1	
CT scan	Orbit bone fracture	1	1	0.005
	Zygomatic fracture	1	0	
	Skull fracture	1	1	

were present in 44.9% participants in present study.

In our study, extraocular movements were restricted in only 2% cases. Red green colour blindness was observed in 8.2% cases whereas color vision could not be elicited in 61.2% cases of TON. Majority of patients with TON showed RAPD in affected eye (79.6%) and ill sustained reaction and sluggishly reacting pupil were observed in 2% cases.

Central and centrocecal scotoma was observed in 12.2% and 10.2% patients respectively and visual fields could not be elicited in maximum i.e. 51% patients in affected eye.

VEP revealed decreased amplitude and increased latency in 28.6% cases with TON, however in 46.9% cases VEP could not be elicited in affected eye.

Vitreous hemorrhage (resolving/ with or without choroid rupture) was observed in 10.2% cases.

The present study observed no significant association of final visual outcome with age, gender and mode of injury. However, visual outcome was significantly poor when time elapsed between injury and treatment was >24 hours and associated fracture of orbital bone or skull bone ($p < 0.05$).

At presentation 73.5% patients presented with very poor visual acuity whereas at final presentation very poor visual acuity was observed in 19 (54.3%) patients and 13 (37.1%) patients had good visual acuity. Visual recovery was observed in 13 (37.1%) patients.

The present study observed statistically highly significant improvement in VEP amplitude as well as amplitude following treatment ($p < 0.01$).

5. Discussion

Our study is aimed to evaluate the visual outcome in cases of traumatic optic neuropathy and to study the reversal of optic nerve function after initiation of treatment. In cases of traumatic optic neuropathy, time of presentation is a crucial factor in visual recovery as it is an ophthalmic emergency which may cause visual morbidity due to direct or indirect damage to the optic nerve that is manifested as deficits in visual fields, color perception and a relative afferent/afferent pupillary defect.

In the current era of industrialization and development, the incidence of traumatic optic neuropathy are increasing in number especially in youngsters who are engaged more in risky environment and are more prone to ocular injuries with greater preponderance in males. Majority of patients in the present study were belonging to 26 to 35 years of age group and mean age of patients was 31.08 ± 13.14 years. These findings were similar to study by Sivakumar et al.,⁶ in which mean age of patients was 32.5 years, 96.5% patients were male whereas only 3.5% females. Chen et al.,⁷ in their study clinical treatment of traumatic optic neuropathy in children included 29 patients, of which 23 were males and 6 were females. This is the productive age group and outdoor as well as indoor activities are higher during this age group. Our study found that 89.8% males

had traumatic optic neuropathy in comparison to females that were only 10.2% indicating incidence of trauma to be higher in males of productive age group as males are more suitable to engage in environment that is riskier and where women are not preferred to work. The gender differences may result from the fact that boys are more active than girls and are thus subject to a higher incidence of traumatic injuries.

In the present scenario, road traffic accidents are the leading cause of fatal and non-fatal injuries amongst people. Also, there are more cases of road traffic accidents due to changing lifestyle and more cases of driving under the influence of alcohol or drug abuse. The most common mode of injury in present study was road traffic accidents (69.4%) followed by fall. These findings were supported by Rajniganth et al.,⁸ in which car crashes followed by falls were the most common risk factors for traumatic optic neuropathy. Sivakumar et al.,⁶ also reported Road Traffic Accident as the most common risk factor for TON in 83.9% patients followed by fall in 10.7% patients. Other causes documented in present study were alleged history of assault and other causes which were due to the lack of responsibility, lack of safety and lack of awareness amongst the majority of population along with the hurried up behavior and sheer disobedience to follow the traffic rules.

The treatment of traumatic optic neuropathy depends upon the underlying cause, mode of injury, timing of initiation of treatment and condition of the patients. However steroid remains the mainstay of treatment for patients with traumatic optic neuropathy. Majority of patients presented with poor visual acuity i.e. PL PR+ (28.6%) followed by counting finger to hand movement in 24.5% patients. Out of 49 patients, 14 patients lost to follow up and the study retained 35 patients at final follow up. However the visual acuity was good (6/6 to 6/36) in 37.1% patients at final follow up. Thus visual recovery was observed in 13 (37.1%) patients.

VEP is important to confirm the diagnosis in comatosed or uncooperative patients. In present study, mean VEP amplitude as well as latency significantly improved following treatment ($p < 0.05$). These findings were similar to study by Rashad et al.,⁹ in which significant improvement was found in BCVA, VER amplitude, and latency ($P < 0.0001$, 0.0154, and 0.0291, respectively) even after 1 injection of steroid.

RAPD was observed in most of the patients. The present study observed no significant association of visual outcome at final follow up with age and gender. Visual recovery and prognosis largely depends upon the time elapsed between commencement of treatment following injury and the mode of injury. Lesser is the difference between the time of injury and, better is the visual outcome. The treatment modality for the patients of traumatic optic

neuropathy is controversial. Steroid therapy remains the mainstay of treatment. Saxena et al.,¹⁰ in their review concluded that methylprednisolone (30 mg/kg loading dose, followed by 5.4 mg/kg/h for 24 h) started within 8 h of injury result in a significant improvement in neurological outcome compared with placebo. Similarly, Sitaula et al.,¹¹ in their retrospective study on traumatic optic neuropathy on 39 patients observed improvement in visual acuity in 5 out of 8 patients who presented within 48 hours of injury and concluded that earlier the treatment was started following injury, better was the prognosis. The findings of present study were consistent with the findings of reference study. The present study documented statistically significant association of visual outcome with time lapse between injury and treatment and associated skull or orbital fracture ($p < 0.05$). Wang et al.,¹² also documented poor visual outcome in patients with associated skull fracture. However Sivakumar et al.,⁶ observed no such association of skull fractures with final visual outcome except in direct impingement of optic nerve.

Hence, decreasing the time taken between injury and onset of medication is the most important factor for visual recovery where lesser time elapsed allows the treatment to act and reverse the damage imparted to the optic nerve caused by the injury. Also, we can choose from the various treatment protocols that suits the patient at that point of time.

6. Conclusion

The pattern of visual recovery depends upon the visual acuity at presentation, type of injury, mode of injury, time elapsed between the injury and initiation of treatment, underlying skull/orbital bone fracture and patient compliance (measured in the form of follow up) as better is the visual acuity at presentation, better is the visual recovery. Overall, the visual recovery was observed in 37.1% cases in our study.

7. Restrictions in the study

1. Patients lost/failed to follow up was a major limitation (despite proper patient and relative counseling).
2. Late presentation/reporting at the institute.
3. Slit lamp examination could not be done in all patients as some patients were unconscious, uncooperative or present in other departments (where slit lamp is not available).
4. Optic nerve examination such as VEP, visual field examination, colour vision etc. could not be elicited in maximum patients.
5. Non/poor compliance of patients to the treatment.
6. Contraindication of steroids in systemic conditions such as diabetes, hypertension or immunocompromised patients.

Areas/Scope of improvement of study

1. Study can be analyzed on the basis of different treatment protocols such as ONTT, IONTS, CRASH and NASCIS-II.
2. Lack of awareness amongst people regarding traumatic optic neuropathy as an emergency condition is an important area which upon improvement can prevent poor visual prognosis.

Future aspect of betterment

1. Spreading awareness regarding proper timely intervention.
2. Prevention of delay in referral from other departments.
3. Ample scope for adjustment/research of dosage of treatment trial on the basis of weight/systemic conditions.
4. Even unconscious/uncooperative patients can be managed after taking written and informed consents from relatives/attendants to prevent permanent optic nerve damage.

8. Source of Funding

None.

9. Conflict of Interest

The authors declare that there is no conflict of interest.

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