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Visual Outcome after Systemic Steroid Therapy in Traumatic Optic Neuropathy

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Abstract

Background: Traumatic optic neuropathy (TON) is an acute injury of the optic nerve due to trauma. It is an ocular emergency that demanding early treatment. Systemic steroids and surgical decompression are the recommended treatment.

Objective: To assess the visual outcomes after systemic steroid therapy among patients with TON.

Methods: This prospective observational study was conducted at Department of Neuro-ophthalmology, National Institute of Ophthalmology and Hospital (NIO&H), Dhaka, Bangladesh, from December 2019 to February 2022, on 48 eyes of 48 patients with TON. Patients were selected on selection criteria; they underwent detail ocular examination as well as relevant investigations. Methylprednisolone 1 gram was given intra-venously for 5 days followed by oral prednisolone tablet 1 mg/kg body weight daily in tapering dose for 2 weeks. They were followed up on 1 week, 1 month and 3 months after starting treatment. Best corrected visual acuity (BCVA) in log MAR unit, color vision by Ishihara pseudoisochromatic chart and relative afferent pupillary defect (RAPD) grades were assessed in each follow up. Morphology of the disc was assessed prior to starting treatment and at final follow up. **Results:** The mean(±SD) base-line BCVA was 0.99±0.22 Log MAR unit, it was 0.89±0.30, 0.69±0.37 and 0.39±0.37 after 1 week, 1 month and 3 months respectively. The mean base-line value of color vision was 1.48±2.27, it was 8.98±3.65, 18.15±7.00 and 23.02±8.66 after 1 week, 1 month and 3 months respectively. We found a significant improvement in RAPD grading at final follow up ($p < 0.001$). Pallor of the disc was found among 20 patients at final follow-up (<0.001).

Conclusion: Visual status of patients with traumatic optic neuropathy improves by systemic steroid therapy. It is evident by significant improvement of visual acuity, color vision and RAPD grading.

Keywords: Ocular Examination; Systemic Steroid Therapy; Traumatic Optic Neuropathy (TON); Visual Outcome

Introuduction

Traumatic optic neuropathy (TON) is an acute injury of the optic nerve secondary to ocular or head injury, characterized by severe irreversible vision loss with relative afferent pupillary defect (RAPD), color vision defect and visual field loss [1-2]. The severity of optic nerve damage may range from simple contusion to comprehensive disinsertion of the nerve fibers from the globe at the level of the lamina cribrosa [3-4]. More recent

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studies on cranio-fascial trauma suggest a higher incidence of TON, which is approximately 2-5% [4]. Optic nerve is very much vulnerable to direct and indirect trauma. When the nerve is injured directly by penetrating injury or from bony fragments in the optic canal or orbit piercing the optic nerve then it is known as direct optic neuropathy [5]. Indirect optic neuropathy occurs when non-penetrating effects of injury causes hemorrhage, edema and concussion in optic disc [5]. Indirect traumatic neuropathy is focus of more clinical research than direct, because direct TON is extremely rare due to protection given by bony orbit. Vision loss associated with indirect traumatic optic neuropathy has more chance of recovery than direct traumatic optic neuropathy [5]. Various risk factors are associated with TON which includes- injuries in road traffic accident, fall from height, frontal impact by falling debris, stab wounds, assault, gunshot, skateboarding, bottle-cork injuries and seemingly trivial injuries; about 79-85% of affected patients with TON are young adult males [1]. TON has been documented following simple blepharoplasty, retrobulbar anesthesia, orbital and endoscopic sinus surgeries and prolonged orthopedic or neurosurgical procedures [4-6]. Diagnosis of TON is made by a careful history and clinical examination. Patients having unilateral optic nerve damage with RAPD following recent trauma without a major open globe injury are refer as TON [7]. Currently the main treatment options for TON include- systemic steroids at different dosages, surgical decompression of the optic canal via intracranial trans-ethmoidal, endo-nasal, sub-labial or other techniques, combination of steroids and surgery or conservative management [1, 8]. Pokharel *et al*., stated that steroids decrease intra-neural and extra-neural edema and relieve optic nerve fibers compression, reducing primary and secondary ischemia of optic nerve [3]. Although, another study revealed that patients with TON had significant improvement after treatment with methylprednisolone but those with very poor vision did not show statistically significant improvement [8]. Sivakumar *et al*., showed that patients with baseline vision ≥ 6/60 improved after high dose IV methylprednisolone but those with very poor baseline vision on and those managed conservatively had not significant improvement [9]. However, less published data are available to evaluate the treatment of different modalities. The largest study on TON is International Optic Nerve Trauma Study (IONTS), which prospectively observed and compared the effect of no treatment, steroid and optic nerve decompression surgery after 2 years observation; they found no significant difference between these modalities [7]. In this background, present study was designed to quantify the outcome of visual status after systemic steroid therapy among patients with TON.

Methodology

Study design

This prospective observational study was carried out at the Department of Neuro-Ophthalmology, National Institute of Ophthalmology and Hospital (NIO&H), Dhaka, Bangladesh from 1st December, 2019 to 28th February 2022. This study was approved by the ethical review committee, NIO&H, Dhaka, Bangladesh.

Study population

A total of 48 patients with TON attending at Department of Neuro-Ophthalmology, NIO&H, Dhaka, Bangladesh who were selected for treatment with intravenous methylprednisolone were enrolled as the study population by purposive sampling technique. Diagnosed patients of TON presented within 7 days of injury and selected for intravenous methyl prednisolone therapy were included. Patients with associated ocular injury that need immediate surgical intervention, patients having ocular disease that hampers proper visualization in posterior segment, patient with systemic disease where corticosteroid was contraindicated, patients with pre-existing ocular surface or intraocular disease, patients with history of ocular surgery or trauma in the previous six months and patients need immediate resuscitations for associated physical injury were excluded from this study.

Study procedure

After selection of the study patients the purpose, procedure and risk/benefits of the study were explained to each patient. Informed written consent was obtained from the patients or their attendants. A detail history was taken from all patients, then their ocular and systemic examinations were performed accordingly. Relevant investigations like-computed tomography (CT) scan of brain and orbit, color fundus photography was done and recorded. Best corrected visual acuity (BCVA) was assessed in Snellen's acuity chart and converted into log MAR unit. Color vision defect was detected clinically by number of plates can read by Ishihara's pseudoisochromatic chart and mean deviation was recorded. RAPD was assessed by swinging flash light test and graded into standard grading scale. Optic disc evaluation was done with 90D condensing lens. Thereafter, methyl prednisolone 1 gram diluted in 100ml normal saline were given intravenously in all study patients for 5 days, after that oral prednisolone tablet was given in 1 mg/kg body weight in tapering dose for 2 weeks. Then advised them to attend follow-up visits after 1 week, 1 month and 3 months of starting treatment. In all follow- up visits; visual acuity, color vision and RAPD grading of the study patients were assessed. Their ocular fundus examination was done at baseline and at final follow-up periods. All the relevant data were recorded in a data collection sheet during baseline to follow-up periods and compared accordingly.

Statistical analysis

Statistical analysis was done by windows-based software

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statistical package for social sciences (SPSS), version- 26. The results were expressed as frequency with percentage and mean with standard deviation (SD) as appropriate. Paired "t" test and Chi square ($\chi 2$) test was performed to compare the data. A p value <0.05 was considered as statistically significant.

Results and Observations

This study was intended to assess visual outcome of the patients with TON after systemic steroid therapy. Total 48 diagnosed patients with TON were included. Outcomes of the steroid therapy were assessed by observing changes in visual acuity, color vision, pupillary light reflex and morphology of the disc from pre-treatment to post-treatment values. The mean(±SD) age of the study patients was 35.35±11.45 years, the age ranged from 10 to 62 years. Out of 48 study patients; 3 patients were 10-20 years age group, 16 patients were 21-30 years age group, 14 patients were 31-40 years age group, 11 patients were 41-50 years age group and the rest 4 patients were more than 50 years age (Table- 1). Of them, 40 (83.3%) were male and 8 (16.7%) were female (Figure- 1).

Table- 1: Distribution of the study patients according to the age (N= 48)

Age group (years)	Frequency (n)	Percentage (%)
10-20	3	6.25
21-30	16	33.33
31-40	14	29.2
41-50	11	22.9
>50	4	8.33
Mean±SD	35.35±11.45 years	
Range	10-62 years	

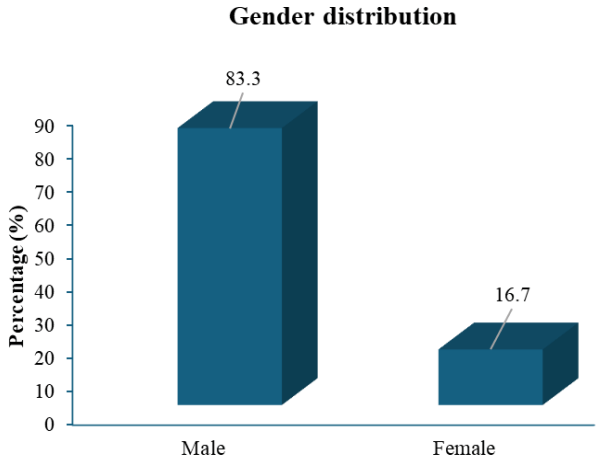

Figure I: Distribution of study patients according to gender (N= 48)

Among 48 patients, involvement of right eye was found in 37(77.1%) patients and involvement of left eye was found in 11(22.9%) patients (Figure- II).

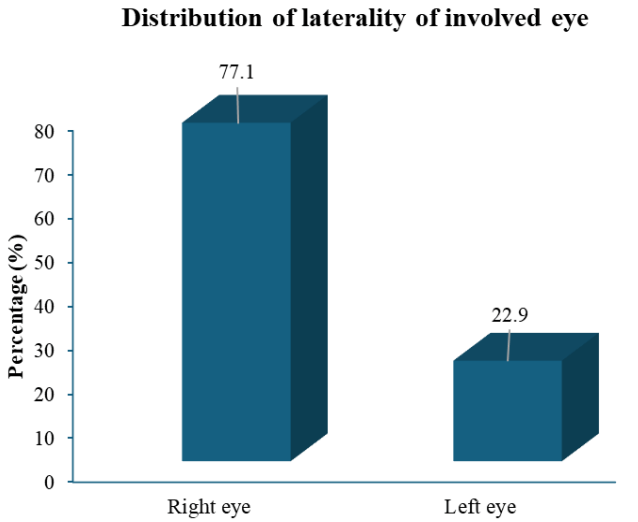

Figure II: Bar diagram showing laterality of involved eye among the study subjects (N=48)

Regarding the mode of injury, 27 (56.3%) patients were following road traffic accident (RTA), 9 (18.8%) were due to assault, 8 (16.7%) were due to fall from height and the rest 4 (8.3%) were due to other causes (Figure- III).

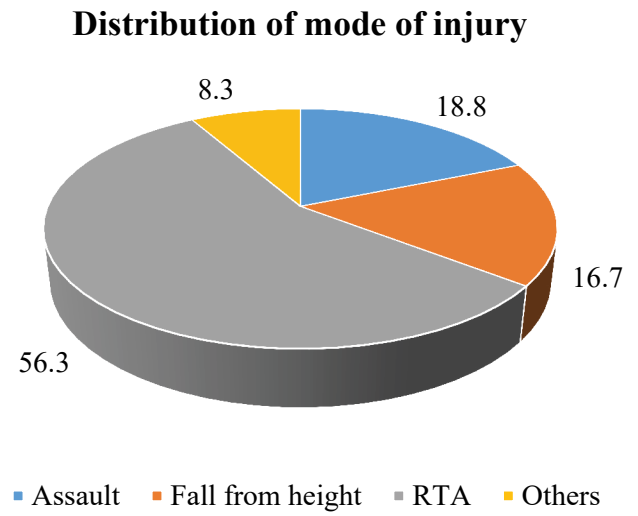

Figure III: Distribution of the study patients according to mode of injury (N= 48)

Table- 2 shows the mean values of best corrected visual acuity (BCVA) of the study patients in Log MAR unit at different assessment periods. The mean(±SD) base-line BCVA was 0.99±0.22 Log MAR unit, it was 0.89±0.30, 0.69±0.37 and 0.39±0.37 respectively after 1 week, 1 month and 3 months of starting treatment respectively (Table- 2).

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Table 2: Distribution of mean values of BCVA (in Log MAR unit) of the study patients at different assessment periods (N= 48)

Assessment periods	BCVA	Mean difference	p value
Baseline	0.99±0.22 (SD)	-	-
1 week after starting treatment	0.89±0.30 (SD)	0.1	<0.001[s]
1 month after starting treatment	0.69±0.37 (SD)	0.3	<0.001[s]
3 months after starting treatment	0.39±0.37 (SD)	0.6	<0.001[s]

s=significant, p value obtained by paired 't' test

Analyzing the mean value of color vision of the study subjects by Ishihara chart in different assessment periods revealed that; the mean(±SD) base-line value of color vision was 1.48±2.27, that was 8.98±3.65, 18.15±7.00 and 23.02±8.66 respectively after 1 week, 1 month and 3 months of starting treatment respectively (Table-3).

The distribution of study patients according to grading of RAPD at different follow-up periods showed that; at presentation 23 (47.9%) patients had grade 5 RAPD, 13 (27.1%) had grade 4 RAPD, 9 (18.8%) had grade 3 RAPD and 3 (6.3%) patients had grade 2 RAPD. It was observed that; 1 week after staring treatment 16 (33.3%) patients had grade 5 RAPD, another 16 (33.3%) had grade 4 RAPD, 11 (22.9%) had grade 3 RAPD and 5 (10.4%) patients had grade 2 RAPD. After 1 month of starting treatment; 6 (12.5%) patients had grade 5 RAPD, 13 (27.1%) had grade 4 RAPD, 17 (35.5%) had grade 3 RAPD and 12 (25%) patients had grade 2 RAPD. During final follow-up (after 3 month of starting treatment); 6 (12.5%) patients had grade 5 RAPD, 4 (8.3%) had grade 4 RAPD, 20 (41.6%) had grade 3 RAPD, 15 (31.3%) had grade 2 RAPD and rest 3 (6.3%) patients had grade 1 RAPD. We found a significant improvement in RAPD grading after starting treatment to final follow up periods ($p<0.001$ in all instances) (Table- 4).

Assessment of the disc condition at base-line showed that 43 (89.5%) patients had normal disc; but pallor of the disc was found in 3(6.25%) patients, edematous disc was in 1 (2.1%) patient and disc hemorrhage was found in 1 (2.1%) patient. At final follow-up 20 (41.6%) patients had disc pallor, which was significant ($p<0.001$). However, no abnormality was detected on disc morphology at presentation and final follow-up in rest of the patients (Table- 5).

Table 3: Distribution of mean values of color vision (by Ishihara chart) of the study patients at different assessment periods (N= 48)

Assessment periods	Color vision	Mean difference	p value
Baseline	1.48±2.27 (SD)	-	-
1 week after starting treatment	8.98±3.65 (SD)	-7.5	<0.001[s]
1 month after starting treatment	18.15±7.00 (SD)	-16.67	<0.001[s]
3 months after starting treatment	23.02±8.66 (SD)	-21.54	<0.001[s]

s=significant, p value obtained by paired t test

Table-4: Distribution of study patients according to RAPD grading at different follow-up periods (N= 48)

Grading of RAPD	At presentation	1 week after treatment	1 month after treatment	3 months after treatment	p value
Grade- 5	23 (47.9%)	16 (33.3%)	6 (12.5%)	6 (12.5%)	<0.001[s]
Grade- 4	13 (27.1%)	16 (33.3%)	13 (27.1%)	04 (8.3%)	<0.001[s]
Grade- 3	9 (18.8%)	11 (22.9)	17 (35.5%)	20 (41.6%)	<0.001[s]
Grade- 2	3 (6.3%)	5 (10.4%)	12 (25.0%)	15 (31.3%)	<0.001[s]
Grade- 1	0	0	0	3 (6.3%)	<0.001[s]

s= significant, p value obtained by $\chi 2$ test

Table-5: Distribution of the study patients according to disc conditions (N= 48)

Disc conditions	Base-line	Final follow-up	p value
Pallor	3 (6.25%)	20 (41.6%)	<0.001[s]
Edema	1 (2.1%)	0	
Hemorrhage	1 (2.1%)	0	

s= significant, p value obtained by $\chi 2$ test

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Discussion

Traumatic optic neuropathy (TON) is a condition where acute injury to the optic nerve from direct or indirect trauma causes vision loss. The different management of TON is still controversial, cause existing data in the literature yet not confirm any treatment modality to be superior [10]. A few studies have supported the use of high dose corticosteroids in TON [3, 10]. This study was conducted at the Department of Neuro-Ophthalmology, a Tertiary Eye Care Hospital in Bangladesh to assess the visual status after systemic steroid treatment among total 48 patients with TON. In this present study, high dose steroid regimen similar to ONTT (OPTIC NEURITIS TREATMENT TRIAL) trial has followed (1gm of intravenous methylprednisolone for 3-5 days followed by 1mg/kg oral prednisolone in tapering dose over 2 weeks) [10]. Data were compared at baseline with that of 1 week, 1 month and 3 months after starting treatment.

In this study, mean(±SD) age of the study subjects was 35.35±11.45 years. Out of 48 study patients, maximum patients (33.33%) were between 21-30 years age followed by 29.16% were in 31-40 years age group and 22.91% were in 41-50 years age group. Majority of the study subjects was young adult as the persons belongs to these active age groups and more liable to trauma. These finding was consistent with related previous studies [3, 10]. In this present study, 40 were male and 8 were female. Almost similar finding was observed in a couple of previous studies [10-11]. Male participants supposed to be more, may be due to male are more exposed to trauma as they mostly involved in outdoor activities. Among the study participants; right eye was involved in 77.1% patients and left eye was involved in 22.9% patients, there were no cases of bilateral TON in this study. This finding was also supported by related previous studies [10-11]. Regarding mode of injury; out of 48 patients 27 were following road traffic accident (RTA), 9 patients were due to assault, 8 were due to fall from height and rest 4 were due to other causes. In this context Chowdhury *et al*., observed that predominant causes of trauma were motor vehicle accident (68.18%), blunt trauma (22.72%) and fall (9.09%) [11]. Another study showed that highest number of respondents belongs to road traffic accident (70%) followed by falls (20%) and rest (10%) was assaults [3]. These findings were comparable with this present study. In this study, base-line BCVA was 0.99±0.22 Log MAR unit, it was 0.89±0.30, 0.69±0.37 and 0.39±0.37 after 1 week, 1 month and 3 months of starting treatment respectively. Visual acuity (VA) supposed to improve in patients of traumatic optic neuropathy after steroid therapy as it reduces inflammatory process and relieves compression by reducing oedema, finally improvement of vision by enhancing optic nerve function. A related study reported that the mean base-line BCVA was 1.52±0.43 Log MAR unit; after intravenous methylprednisolone, it was 1.24±0.70, 0.96±0.72 and 0.42±0.42 Log MAR unit 1 week, 1 month and 3 months later respectively [12]. These findings were compatible with the present study. In accordance Sitaula *et al*., demonstrated that, high-dose (1 gm/day) intravenous methylprednisolone led to significant improvement in final visual acuity among patients with TON [4]. However, one previous study showed that patients with very poor baseline vision, after high dose intravenous methylprednisolone therapy and those managed conservatively did not show significant improvement [9]. In this present study, mean base-line value of color vision was1.48±2.27, it was 8.98±3.65, 18.15±7.00 and 23.02±8.66 respectively after 1 week, 1 month and 3 months of starting treatment. It was reported that optic nerve functions start to improve after steroid therapy which in-turn causes improvement of color vision [12]. Menon *et al*., performed a prospective case control study and showed that the base-line value of color vision among the study population was zero (0); their color vision was improved 7.33±8.55, 17.50±9.81 and 21.33±5.9 respectively at 1 week, at 1 month and 3 months after intravenous methylprednisolone therapy [12]. They enumerated that the change in color vision in terms of number of plates read was significantly improved after treatment from a value of mean zero (0) plates read [12]. Color vision improvement after 7 days of treatment (intravenous methylprednisolone therapy) was also observed in a related previous study [3]. These observations were closely resembled to our findings.

Regarding relative afferent pupillary defect (RAPD) of the study subjects, a significant improvement in RAPD grading was observed after starting treatment to final follow up periods. It was documented that RAPD grading and other ophthalmoscopic parameters were improved after steroid treatment [13]. In this present study, disc morphology at presentation showed that; 89.5% patients had normal disc; on the other hand, pallor of the disc was found in 6.25% patients, edematous disc was observed in 2.1% patient and disc hemorrhage was found in 2.1% patient. At final follow-up a significant patients had disc pallor; however, maximum patients had no abnormality on disc morphology at presentation and at final follow-up. In this context, Pokhrel *et al*., observed that majority of their study cases (75%) had onset of pallor disc by 2 weeks after trauma in steroid group while in no treatment group majority had pallor disc at the time of presentation as their presentation was late [3]. Evaluation of visual field is an important parameter to assess visual status. In this study, as most of our study patients presented with poor vision, therefore a complete visual field assessment was not possible. Traumatic optic neuropathy (TON) may result in profound loss of vision. Immediate measures should be done to decompress optic nerve due to oedema as well as minimization of inflammation in earliest possible time to restore optic nerve function. In this prospect systemic steroid therapy could be a choice of treatment.

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Conclusion

This study shows that systemic steroid therapy improves visual status of patients with traumatic optic neuropathy. It is evident by significant improvement of visual acuity, color vision and relative afferent pupillary defect (RAPD) grading.

Limitations of the study

This current study has several limitations. The sample size was relatively small. The influence of presenting vision on final visual outcomes were not analyzed. Relative afferent pupillary defect (RAPD) was graded qualitatively; it was not quantitatively analyzed by neutral density filter. This study had no control group to compare the outcomes. Moreover, long-term systemic effects of steroid were not analyzed.

Recommendations

Further study should be done in randomized clinical trial design to assess the efficacy of systemic steroid over other modalities of treatment on traumatic optic neuropathy. A long-term assessment of visual outcome after steroid therapy should done and that should be compared with controls.

Conflicts of interest

All authors declared that there is no conflict of interest regarding this publication.

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