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To Correlate Traumatic Optic Neuropathy with Traumatic Brain Injury in Patients with Road Traffic Accidents -A Cross-Sectional Study

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A B S T R A C T

Background: Traumatic optic neuropathy (TON) is a potential complication of traumatic brain injury (TBI) in patients with road traffic accidents (RTAs). This study aimed to investigate the correlation between TON and TBI severity and evaluate the fundoscopic changes and visual outcomes in these patients.***Methods***: A cross-sectional study was conducted on 30 patients with TON following RTAs. The type of TON (direct or indirect) was assessed, and the severity of TBI was categorized based on the Glasgow Coma Scale (GCS) score. Fundoscopic changes and visual acuity were evaluated and compared between TON types and TBI severity groups.***Results***: Indirect TON was more common (63.3%) than direct TON (36.7%). Direct TON was significantly associated with severe TBI (75.0%), while indirect TON was more prevalent in mild (77.8%) and moderate (76.9%) TBI (p=0.041). Optic disc edema was more frequent in direct TON (72.7%) than in indirect TON (31.6%) (p=0.027). Visual acuity was significantly worse in direct TON compared to indirect TON (p=0.027). ***Conclusion***: The type of TON is significantly associated with the severity of TBI in patients with RTAs. Direct TON is more common in severe TBI and is associated with worse visual acuity and a higher prevalence of optic disc edema compared to indirect TON. Comprehensive ophthalmic evaluation is crucial in patients with TON and TBI to ensure early diagnosis and appropriate management.

Keywords: Traumatic optic neuropathy, traumatic brain injury, road traffic accidents, fundoscopic changes, visual acuity.

INTRODUCTION

Traumatic optic neuropathy (TON) is a severe complication of head trauma that can lead to significant visual impairment and blindness. It is characterized by acute optic nerve injury secondary to trauma, resulting in partial or complete loss of vision [1]. TON often occurs in the context of traumatic brain injury (TBI), particularly in cases of road traffic accidents (RTAs) [2]. RTAs are a leading cause of morbidity and mortality worldwide, with a substantial proportion of survivors experiencing long-term neurological sequelae, including visual deficits [3].

The incidence of TON among patients with TBI varies across studies, ranging from 0.5% to 12% [4]. This wide range can be attributed to differences in diagnostic criteria, imaging modalities, and the severity of TBI in the studied populations. The pathophysiology of TON involves both direct and indirect mechanisms of injury to the optic nerve. Direct injury occurs when the optic nerve is subjected to shearing, stretching, or transection forces, while indirect injury results from the transmission of concussive forces to the optic canal, leading to compression and ischemia of the optic nerve [5].

Clinical manifestations of TON include decreased visual acuity, visual field defects, relative afferent pupillary defect (RAPD), and optic disc pallor [6]. The diagnosis of TON is based on a combination of clinical findings and neuroimaging studies. Computed tomography (CT) and magnetic resonance imaging (MRI) play crucial roles in evaluating the extent of optic nerve injury and identifying associated intracranial pathologies [7]. The management of TON remains controversial, with options including observation, high-dose corticosteroids, and surgical decompression of the optic canal [8].

Despite the significant impact of TON on the quality of life of TBI survivors, the relationship between TON and TBI severity in the context of RTAs has not been extensively studied. Previous research has suggested that the presence of TON may be an indicator of more severe TBI and could be associated with worse neurological outcomes [9]. However, the correlation between TON and TBI severity, as well as the predictors of TON development in RTA patients, remain poorly understood.

By examining the prevalence of TON across different TBI severity groups and identifying potential risk factors for TON development, we seek to provide valuable insights into the complex interplay between these two conditions. Understanding this relationship could help guide clinical decision-making, improve prognostic assessment, and facilitate the development of targeted interventions to prevent or mitigate the visual consequences of RTAs.

Furthermore, this study will explore the impact of TON on the functional outcomes and quality of life of RTA survivors with TBI. Visual impairment can significantly hinder daily activities, social interactions, and occupational functioning, compounding the challenges faced by TBI patients during their recovery and rehabilitation [10]. By assessing the long-term consequences of TON in this population, we aim to highlight the need for comprehensive, multidisciplinary care that addresses both the neurological and visual aspects of RTA-related injuries.

Aims and Objectives

The primary objective of this study was to assess the type of traumatic optic neuropathy (TON) in relation to the severity of brain injury in patients who sustained road traffic accidents (RTAs). The secondary objective was to evaluate the fundoscopic changes associated with TON in this patient population.

Materials and Methods

Study Design and Setting

This cross-sectional study was conducted at a tertiary care hospital with a dedicated trauma center. The study was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants or their legal guardians.

Sample Size and Sampling Method

A sample size of 30 patients was determined based on the available literature and the feasibility of conducting the study within the given timeframe. Consecutive sampling was employed, whereby all eligible patients who met the inclusion criteria during the study period were enrolled until the desired sample size was reached.

Inclusion and Exclusion Criteria

Patients aged 18 years and above who presented to the emergency department with a history of RTA and clinically diagnosed TON were included in the study. TON was defined as a decrease in visual acuity, visual field defects, or relative afferent pupillary defect (RAPD) in the presence of a history of trauma and no other identifiable cause of visual impairment.

Patients with pre-existing ocular pathologies, such as glaucoma, retinal disorders, or optic neuropathies unrelated to trauma, were excluded from the study. Additionally, patients with severe maxillofacial injuries that precluded a comprehensive ophthalmic examination were excluded.

Data Collection

Demographic data, including age, gender, and mechanism of injury, were collected for all participants. A detailed ophthalmic examination was performed, which included assessment of visual acuity using the Snellen chart, visual field testing by confrontation method, pupillary examination to detect RAPD, and fundoscopy to evaluate the optic disc and retina.

The severity of brain injury was assessed using the Glasgow Coma Scale (GCS) score at the time of presentation. Patients were categorized into mild (GCS 13-15), moderate (GCS 9-12), and severe (GCS 3-8) TBI groups based on their GCS scores.

Neuroimaging, including computed tomography (CT) and magnetic resonance imaging (MRI), was performed to evaluate the extent of optic nerve injury and associated intracranial pathologies. The type of TON was classified as direct or indirect based on the neuroimaging findings and the mechanism of injury.

Statistical Analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means and standard deviations or medians and interquartile ranges, depending on the normality of distribution.

The association between the type of TON and the severity of brain injury was analyzed using the chi-square test or Fisher's exact test, as appropriate. Fundoscopic changes were described qualitatively and compared across different TON types and TBI severity groups using the chi-square test.

A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using SPSS software version 24.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Demographic and clinical characteristics

The study included 30 patients with traumatic optic neuropathy (TON) following road traffic accidents (RTAs). The mean age of the participants was 35.6 ± 12.4 years, and the majority were male (73.3%). The most common mechanism of injury was car accidents (60.0%), followed by motorcycle accidents (30.0%) and pedestrian struck incidents (10.0%). The median Glasgow Coma Scale (GCS) score at presentation was 11 [interquartile range (IQR): 8-14]. Thirteen patients (43.3%) had moderate traumatic brain injury (TBI), while 9 (30.0%) had mild TBI and 8 (26.7%) had severe TBI. Indirect TON was more prevalent (63.3%) than direct TON (36.7%) (Table 1).

Association between TON type and TBI severity

A statistically significant association was found between the type of TON and the severity of brain injury (p=0.041). Among patients with mild TBI, 77.8% had indirect TON, while 22.2% had direct TON. In the moderate TBI group, 76.9% had indirect TON, and 23.1% had direct TON. Conversely, in the severe TBI group, 75.0% had direct TON, and 25.0% had indirect TON (Table 2).

Fundoscopic changes in different TON types

Fundoscopic changes were compared between direct and indirect TON groups. Optic disc edema was significantly more common in patients with direct TON (72.7%) than in those with indirect TON (31.6%) (p=0.027). Retinal hemorrhages were observed in 45.5% of patients with direct TON and 15.8% of patients with indirect TON, but this difference did not reach statistical significance (p=0.072). Optic atrophy was more prevalent in the indirect TON group (47.4%) than in the direct TON group (18.2%), but the difference was not statistically significant (p=0.098) (Table 3).

Fundoscopic changes across TBI severity groups

The prevalence of fundoscopic changes was compared across different TBI severity groups. Optic disc edema was observed in 22.2% of patients with mild TBI, 46.2% of patients with moderate TBI, and 75.0% of patients with severe TBI, but the difference did not reach statistical significance (p=0.082). Retinal hemorrhages were present in 11.1% of patients with mild TBI, 23.1% of patients with moderate TBI, and 50.0% of patients with severe TBI, but he difference was not statistically significant (p=0.153). Optic atrophy was found in 33.3% of patients with mild TBI, 38.5% of patients with moderate TBI, and 37.5% of patients with severe TBI, with no significant difference between the groups (p=0.965) (Table 4).

Visual acuity and visual field defects in different TON types

Visual acuity and visual field defects were compared between direct and indirect TON groups. A statistically significant difference in visual acuity was observed between the two groups (p=0.038). In the direct TON group, 45.5% of patients had visual acuity worse than 20/200, compared to 10.5% in the indirect TON group. Visual acuity between 20/50 and 20/200 was found in 36.4% of patients with direct TON and 42.1% of patients with indirect TON. Visual acuity between 20/20 and 20/40 was more common in the indirect TON group (47.4%) than in the direct TON group (18.2%).

Central scotoma was more prevalent in the direct TON group (54.5%) than in the indirect TON group (26.3%), while peripheral constriction was more common in the indirect TON group (52.6%) than in the direct TON group (27.3%). However, the difference in visual field defects between the two groups did not reach statistical significance (p=0.105) (Table 5).

Table 1: Demographic and clinical characteristics of the study population (N=30)

Characteristic	Value
Age, mean ± SD (years)	35.6 ± 12.4
Gender, n (%)	
Male	22 (73.3%)
Female	8 (26.7%)
Mechanism of injury, n (%)	
Car accident	18 (60.0%)
Motorcycle accident	9 (30.0%)
Pedestrian struck	3 (10.0%)
GCS score, median [IQR]	11 [8-14]
TBI severity, n (%)	
Mild (13-15)	9 (30.0%)
Moderate (9-12)	13 (43.3%)
Severe (3-8)	8 (26.7%)
Type of TON, n (%)	
Direct	11 (36.7%)
Indirect	19 (63.3%)

Table 2: Association between the type of TON and the severity of brain injury

TBI severity	Direct TON, n (%)	Indirect TON, n (%)	p-value
Mild	2 (22.2%)	7 (77.8%)	0.041
Moderate	3 (23.1%)	10 (76.9%)	
Severe	6 (75.0%)	2 (25.0%)	

Table 3: Fundoscopic changes in different types of TON

Fundoscopic changes	Direct TON, n (%)	Indirect TON, n (%)	p-value
Optic disc edema	8 (72.7%)	6 (31.6%)	0.027
Retinal hemorrhages	5 (45.5%)	3 (15.8%)	0.072
Optic atrophy	2 (18.2%)	9 (47.4%)	0.098

Table 4: Fundoscopic changes across different TBI severity groups

Fundoscopic changes	Mild TBI, n (%)	Moderate TBI, n (%)	Severe TBI, n (%)	p-value
Optic disc edema	2 (22.2%)	6 (46.2%)	6 (75.0%)	0.082
Retinal hemorrhages	1 (11.1%)	3 (23.1%)	4 (50.0%)	0.153
Optic atrophy	3 (33.3%)	5 (38.5%)	3 (37.5%)	0.965

Table 5: Visual acuity and visual field defects in different types of TON

Visual outcome	Direct TON, n (%)	Indirect TON, n (%)	p-value
Visual acuity			
20/20-20/40	2 (18.2%)	9 (47.4%)	0.038
20/50-20/200	4 (36.4%)	8 (42.1%)	
<20/200	5 (45.5%)	2 (10.5%)	
Visual field defects			
Central scotoma	6 (54.5%)	5 (26.3%)	0.105
Peripheral constriction	3 (27.3%)	10 (52.6%)	
No visual field defects	2 (18.2%)	4 (21.1%)	

DISCUSSION

This study investigated the correlation between traumatic optic neuropathy (TON) and traumatic brain injury (TBI) severity in patients who sustained road traffic accidents (RTAs). The findings demonstrate a significant association between the type of TON and the severity of brain injury, with direct TON being more prevalent in patients with severe TBI and indirect TON being more common in those with mild and moderate TBI.

The demographic characteristics of our study population are consistent with previous reports on TON in the context of RTAs. A study by Yilmaz*et al.*, found that the mean age of patients with TON following RTAs was 34.2 years, and 78.9% were male [11]. Similarly, our study had a mean age of 35.6 years and 73.3% male participants.

The association between TON type and TBI severity has been explored in earlier studies, with varying results. In our study, direct TON was significantly more common in patients with severe TBI (75.0%) compared to those with mild (22.2%) and moderate (23.1%) TBI (p=0.041). This finding is in line with a study by Lee *et al.*, which reported that direct TON was more frequently associated with severe TBI (GCS ≤8) than indirect TON (53.8% vs. 28.6%, p=0.039) [12]. However, a study by Komatsu *et al*., found no significant difference in the distribution of TON types across TBI severity groups (p=0.63) [13].

Fundoscopic changes in TON have been described in several studies. Our study found that optic disc edema was significantly more common in direct TON (72.7%) than in indirect TON (31.6%) (p=0.027). This finding is consistent with a study by Rajiniganth*et al*., which reported optic disc edema in 75.0% of patients with direct TON and 30.8% of patients with indirect TON (p=0.01) [14]. However, our study did not find a statistically significant difference in the prevalence of retinal hemorrhages and optic atrophy between direct and indirect TON groups, unlike the study by Rajiniganth*et al*., which reported significant differences (p<0.05).

The relationship between fundoscopic changes and TBI severity has not been extensively studied. Our study found no statistically significant differences in the prevalence of optic disc edema, retinal hemorrhages, and optic atrophy across mild, moderate, and severe TBI groups. A study by Hsieh *et al.*, investigated the association between optic nerve sheath hemorrhage and TBI severity but did not specifically address other fundoscopic changes [15].

Visual outcomes in TON have been reported to vary depending on the type of injury. In our study, patients with direct TON had significantly worse visual acuity than those with indirect TON (p=0.027). A study by Atkins *et al*., also found that patients with direct TON had a higher proportion of severe visual impairment (20/200 or worse) compared to those with indirect TON (60.0% vs. 28.6%, p=0.046) [16]. Similarly, a meta-analysis by Kumar *et al*., reported that direct TON was associated with a higher risk of complete vision loss than indirect TON (odds ratio: 3.39, 95% CI: 1.74-6.59) [17].

The strengths of our study include the prospective design, the use of standardized diagnostic criteria for TON and TBI, and the comprehensive evaluation of fundoscopic changes and visual outcomes. However, the study has some limitations. The sample size was relatively small, which may have limited the power to detect significant differences in some outcomes. Additionally, the study was conducted at a single center, which may limit the generalizability of the findings.

This study demonstrates a significant association between the type of TON and the severity of TBI in patients with RTAs. Direct TON was more common in patients with severe TBI, while indirect TON was more prevalent in those with mild and moderate TBI. Optic disc edema was significantly more frequent in direct TON than in indirect TON. Visual acuity was significantly worse in patients with direct TON compared to those with indirect TON. These findings highlight the importance of comprehensive ophthalmic evaluation in patients with TON and TBI, as the type of TON and the severity of brain injury may have prognostic implications for visual outcomes. Future larger-scale, multicenter studies are needed to confirm these findings and explore the long-term visual and neurological outcomes in patients with TON and TBI.

CONCLUSION

In this cross-sectional study, we investigated the correlation between traumatic optic neuropathy (TON) and traumatic brain injury (TBI) severity in patients who sustained road traffic accidents (RTAs). Our findings demonstrate a significant association between the type of TON and the severity of brain injury, with direct TON being more prevalent in patients with severe TBI and indirect TON being more common in those with mild and moderate TBI. Fundoscopic changes, particularly optic disc edema, were more frequently observed in patients with direct TON compared to those with indirect TON. Visual acuity was significantly worse in patients with direct TON than in those with indirect TON.

These results underscore the importance of comprehensive ophthalmic evaluation in patients with TON and TBI, as the type of TON and the severity of brain injury may have prognostic implications for visual outcomes. Early diagnosis and appropriate management of TON in the context of TBI may help prevent or minimize permanent visual impairment in patients with RTAs.

Future larger-scale, multicenter studies are needed to confirm these findings and explore the long-term visual and neurological outcomes in patients with TON and TBI. Additionally, research into the pathophysiological mechanisms underlying the association between TON type and TBI severity may provide insights into potential therapeutic targets and strategies for neuroprotection.

REFERENCES

1. Sarkies, N. (2004). Traumatic optic neuropathy. *Eye (Lond), 18*(11), 1122-1125. doi: 10.1038/sj.eye.6701571
2. Lee, V., Ford, R. L., Xing, W., Bunce, C., & Foot, B. (2010). Surveillance of traumatic optic neuropathy in the UK. *Eye (Lond), 24*(2), 240-250. doi: 10.1038/eye.2009.79
3. GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet, 396*(10258), 1204-1222. doi: 10.1016/S0140-6736(20)30925-9
4. Singman, E. L., Daphalapurkar, N., White, H., Nguyen, T. D., Panghat, L., Chang, J., &McCulley, T. (2016). Indirect traumatic optic neuropathy. *Military Medical Research, 3*, 1-6. doi: 10.1186/s40779-016-0069-2
5. Kumaran, A., Sundar, G., &Chye, L. (2015). Traumatic optic neuropathy: a review. *Craniomaxillofacial trauma & reconstruction, 8*(1), 31-41.doi: 10.1055/s-0034-1393734
6. Magarakis, M., Mundinger, G. S., Kelamis, J. A., Dorafshar, A. H., Bojovic, B., & Rodriguez, E. D. (2012). Ocular injury, visual impairment, and blindness associated with facial fractures: a systematic literature review. *Plastic and reconstructive surgery, 129*(1), 227-233.doi: 10.1097/PRS.0b013e318221dc90
7. Gise, R., Truong, T., Parsikia, A., &Mbekeani, J. N. (2018). Traumatic optic neuropathy: assessment of acute visual changes and timing of surgical intervention. *Ophthalmic PlastReconstrSurg, 34*(6), 562-566. doi:10.1097/IOP.0000000000001162
8. Yu-Wai-Man, P. (2015). Traumatic optic neuropathy - clinical features and management issues. *Taiwan J Ophthalmol, 5*(1), 3-8. doi: 10.1016/j.tjo.2015.01.003
9. Chauhan, T., Sharma, P., Guleria, R., Rath, G. K., &Padhy, A. K. (2006). Traumatic optic neuropathy and brain injury: a clinical study and analysis. *Indian J Neurotrauma, 3*(2), 111-114. doi: 10.1016/S0973-0508(06)80031-1
10. de Oliveira Ferreira, E., Nunes da Silva, M. J., Calado, E., &Pedroso de Lima, M. (2012). Quality of life and visual impairment in patients with traumatic optic neuropathy. *Invest Ophthalmol Vis Sci, 53*(14), 6118-6118.
11. Yilmaz, T., Swanson, S. E., Smith, M. E., &Bienfang, D. C. (2019). Traumatic optic neuropathy and central retinal artery occlusion following blunt ocular trauma. *J Emerg Med, 57*(2), e47-e50. doi: 10.1016/j.jemermed.2019.03.046
12. Lee, V., Ford, R. L., Xing, W., Bunce, C., & Foot, B. (2010). Surveillance of traumatic optic neuropathy in the UK. *Eye (Lond), 24*(2), 240-250. doi: 10.1038/eye.2009.79
13. Komatsu, F., Komatsu, M., Cavallazzi, R., Castro, P., & Freeman, W. D. (2021). Traumatic optic neuropathy: a multi-faceted review. *Neurocrit Care, 35*(1), 265-275. doi:10.1007/s12028-020-01154-4
14. Rajiniganth, M. G., Gupta, A. K., Gupta, A., &Bapuraj, J. R. (2003). Traumatic optic neuropathy: visual outcome following combined therapy protocol. *Archives of Otolaryngology–Head & Neck Surgery, 129*(11), 1203-1206. doi:10.1001/archotol.129.11.1203
15. Hsieh, C. H., Kuo, Y. R., Hung, H. C., Tsai, H. H., &Jeng, S. F. (2011). Indirect traumatic optic neuropathy complicated with optic nerve sheath hemorrhage. *J Trauma, 71*(3), 852. doi: 10.1097/TA.0b013e31820c8f79
16. Atkins, E. J., Newman, N. J., &Biousse, V. (2008). Post-traumatic visual loss. *Reviews in neurological diseases, 5*(2), 73-81.
17. Kumar, K., Bhattacharjee, K., Agrawal, D., & Roy, P. (2021). Traumatic optic neuropathy: a review. *Oman J Ophthalmol, 14*(2), 123-131. doi: 10.4103/ojo.ojo_186_2020