# OCULAR MANIFESTATIONS OF HEAD INJURIES

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**ABSTRACT**

**BACKGROUND**

This prospective study aimed to evaluate the incidence of ocular manifestations in head injury and their correlation with the intracranial lesions.

**MATERIALS AND METHODS**

A total of 108 consecutive cases of closed head injury admitted in the neurosurgical ward of a tertiary teaching hospital underwent a thorough ophthalmic assessment. Clinical examination, radiological imaging and Glasgow Coma Scale (GCS) were applied to grade the severity of injury.

**RESULTS**

Total number of 108 patients of head injury were examined of which 38 patients had ocular manifestations (35.18%). Of these, 85.18% were males, 84% of injuries were due to road traffic accidents and 16% were due to fall from a height. The ocular manifestations were as follows- Orbital complications were seen in 6 patients (15.8%). Anterior segment manifestations included black eyes seen in 10 patients (26.3%), subconjunctival haemorrhage in 10.5% of patients (4 patients), corneal involvement in 21% of patients (8 patients) and pupillary involvement in 50% of patients (19 patients). Posterior segment manifestations were seen in 26.3% of patients (10 patients) and were as follows- Purtscher's retinopathy in 2 patients and optic atrophy in 5 patients. Cranial nerve palsies were seen in 15 patients (39.47%) and supranuclear movement disorders were seen in 3 patients (8%).

**CONCLUSION**

Even though, neurosurgeons perform comprehensive clinical examination including eye examination, the main purpose is limited to aid topical diagnosis of neurological lesions. This study emphasises the importance of a detailed eye examination by an ophthalmologist to prevent irreversible visual loss in addition to aiding in the neurological diagnosis. Pupillary involvement, papilloedema and ocular motor paresis pointed to a more severe head injury. This observational prospective study helped us to correlate the severity of head injuries in association with ocular findings in patients admitted in neurosurgical ward and in patients reported to Department of Ophthalmology with a history of head injury.

**KEYWORDS**

Traumatic Brain Injury, Traumatic Optic Neuropathy, Cranial Nerve Palsies, Hutchison's Pupil.

**HOW TO CITE THIS ARTICLE:** Rao KVM, Ratna Kumari BVS. Ocular manifestations of head injuries. J. Evid. Based Med. Healthc. 2016; 3(100), 5545-5549. DOI: 10.18410/jebmh/2016/1147

## BACKGROUND

Ocular trauma is the cause of blindness in more than half a million people worldwide and a cause for partial loss of sight in many more and it is often the leading cause of unilateral loss of vision particularly in developing countries.[1] Traumatic brain injury is a critical public health and socioeconomic problem throughout the world. It is a major cause of death especially among young adults[2] and lifelong morbidity and disability in those who survive. In India, it is estimated that nearly 1.5 to 2 million persons are injured and 1 million succumb to death every year.[3] The incidence of TBI as measured by combined emergency department visits, hospitalisations and death has steadily risen from 2001-2010. Data from CDC indicate that each year in USA, 1.7 million sustain TBI.[4] From 2001 to 2010, TBI rates increased from 521 to 824/per 1,00,000 population (CDC 2014). Between 3.2 and 5.3 million[5] persons (1.1%-1.7% of US population) live with long-term disability from TBI and in European Union approximately 7.7 million[6] people who have experienced TBI have disabilities and about 30-50% of these are associated with ocular and visual defects, which is an approximate estimate.[7] The role of ocular injuries secondary to head trauma in the causation of blindness has become a subject of immense importance. TBI leads to neurocognitive deficits such as impaired attention, inability to perform visuospatial associations and psychological health issues. TBI is considered a silent epidemic as society is unaware of magnitude of the problem. The manifestations of head injury and its numerous other systemic complications are so compelling that damage to the visual system is most likely to be ignored. Many a times, when the eye is examined as

*Financial or Other, Competing Interest: None.*
*Submission 23-11-2016, Peer Review 30-11-2016,*
*Acceptance 13-12-2016, Published 15-12-2016.*
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*DOI: 10.18410/jebmh/2016/1147*

part of neurological assessment of a patient with head injury, the purpose is mainly to gauge the severity of the head injury itself. Many hypotheses have been advanced to explain the cause of head injuries, but most of these hypotheses have remained untested and unproven. With respect to soft tissue injuries to the globe and adnexa in the anterior segment of the eye, one hypothesis suggested that energy is transferred to these structures from the sturdy frontal bones to the orbit and from the lateral orbital margin to contiguous facial structures during the impact following head injury. Disorders of eye movement are thought to result from direct trauma to orbital contents, cranial nerves and other brain areas.

In spite of the significance of problems associated with ocular manifestations of head injury, only few reviews of the whole spectrum are available in the literature. The aim of this study was to evaluate the clinical profile of ocular and visual complications in patients hospitalised and managed for head injury at our hospital.

## MATERIALS AND METHODS

The clinical study of "ocular manifestations in head injuries" was undertaken in those patients admitted following head injury in neurosurgery ward and patients who attended Outpatient Department of Ophthalmology in a tertiary teaching hospital in Visakhapatnam. This study was done over a period of 18 months and comprised prospective analysis of 108 patients diagnosed as head injury. All patients were reviewed and followed up by an ophthalmologist for signs and symptoms of ocular morbidity, which were subsequently analysed.

Detailed ophthalmological examination could not be done for patients from neurosurgery ward as most of them were unconscious and are not in a position to complain about their ocular problems and their examination was limited to examination with a torchlight with observation of pupillary reflexes, direct and indirect ophthalmoscopy. In those patients who were conscious, coherent, able to sit, a bedside visual acuity testing by Snellen's visual acuity chart, visual field examination by confrontation method, direct and indirect ophthalmoscopy and whenever possible anterior segment examination by slit lamp biomicroscope was done. These examination procedures were assisted by radiological investigations like x-rays, CT or MRI. Visual acuity was tested by finger counting, Snellen's chart, visual field by Humphrey's automated perimeter and intraocular pressure was recorded by applanation tonometer/Tono-Pen, assessment of colour vision by Ishihara's charts. Visual acuity, evaluation of extraocular movements, diplopia testing, strabismus evaluation, visual field charting could not be carried out in all patients.

Statistical analysis of the data was performed by professional biomedical statistician. The analysis of data was performed for all variables. Test of goodness of fit chi-square test was used to compare proportions. Confidence intervals of 95% were employed. P values <0.05 were considered statistically significant.

## RESULTS

In our study of 108 cases of head injury, 16 (14.81%) were females and 92 (85.18%) were males. The age ranged from 3 years to 68 years with a mean of 29.52 years±15.87, median of 28 years. Most of the patients who sustained head injuries were young adult males in 21-40 years age group (53/108, 49.07%). Amongst 38 patients who manifested with ocular signs after head injury, majority of the patients were in 21-30 years age group (16/38, 42.10%), 36 were males (94.74%) and females constituted 5.28% (2). The association of age and gender with TBI was statistically significant (p<0.001). A majority of patients sustained head injuries in road traffic accidents (84.21%) followed by fall (15.79%). The statistical association of road traffic accidents and TBI was significant (P<0.001).

**Demographic Profile (n=38)**

| Age Group | Number of Cases with Ocular Manifestation | P value |
|---|---|---|
| Up to 10 Years | 2 (5.26%) | <0.01 |
| 11-20 Years | 9 (23.68%) | |
| 21-30 Years | 16 (42.10%) | |
| 31-40 Years | 5 (13.15%) | |
| 41-50 Years | 4 (10.52%) | |
| 51 and above | 2 (5.26%) | |

***Table 1. Demographic Profile (n=38)***

| Gender | Number of Patients | P value |
|---|---|---|
| Male | 36 (94.74%) | <0.001 |
| Female | 2 (5.26%) | |

| Mode of Injury | Number of Patients | P value |
|---|---|---|
| Road Traffic accidents | 32 (84.21%) | <0.001 |
| Fall from a height | 6 (15.79%) | |

Ophthalmic manifestations were observed in 38 patients (35.18%) due to head injury and 24 patients (63.15%) had unilateral ocular manifestations and 14 patients (36.84%) had bilateral ocular manifestations. In patients with ophthalmic manifestations, the ocular signs appeared within 2 days in 15 patients (39.5%) within 1$^{st}$ week in 15 patients (39.5%), after a week in 8 patients (21%). Neuro-ophthalmic abnormalities were observed in 22/38 patients (57.89%). The common craniocerebral lesion causing ocular manifestation was intracranial haematoma in 16 patients (42.10%) followed by skull fractures in 11 patients (28.9%), diffuse brain stem injury and indirect ocular contusions were seen in 11 patients (28.9%). Though intracranial haematomas were the leading cause of ocular manifestations, there was no statistical significant association between various intracranial lesions and incidence of neuro-ophthalmic manifestations (P>0.05).

**Craniocerebral Lesions (n=38)**

| Craniocerebral Lesions | Number of Patients | P value |
|---|---|---|
| Skull fractures | 11 (28.95%) | >0.05 |
| Intracranial haematoma | 16 (42.10%) | |
| Miscellaneous | 11 (28.95%) | |

***Table 2. Craniocerebral Lesions (n=38)***

Anterior segment manifestations were observed in 32 patients (84.21%). The commonest ocular complication was ecchymosis in 10 patients (26.31%) followed by subconjunctival haemorrhage in 4 patients (10.5%) and exposure keratitis in 5 patients (13.15%), neuroparalytic keratitis in 3 patients (7.89%), traumatic mydriasis in 3 patients (7.89%). Posterior segment complications were seen in 10 patients (26.31%). They were Purtscher's retinopathy in 2 patients (5.26%), Terson's syndrome in 1 patient (2.63%), macular oedema in 2 patients (5.26%) and optic atrophy in 5 patients (13.15%).

Orbital complications were observed in 6 cases (15.78%). Of these, 3 patients had orbital fracture (7.89%), 2 patients had orbital haematomas (5.26%), 1 patient had orbital emphysema (2.63%).

**Ocular Complications (n=38)**

| Soft Tissue Injuries to the Globe and Adnexa | |
|---|---|
| **Anterior Segment Manifestations** | **Number of Patients** |
| Black eyes | 10 (26.31%) |
| Subconjunctival haemorrhage | 4 (10.5%) |
| **Corneal Involvement-**<br>Exposure keratitis<br>Neuroparalytic keratitis | <br>5 (13.15%)<br>3 (7.89%) |
| **Pupillary abnormalities** | 19 (50%) |
| **Posterior Segment Manifestations** | **Number of Patients** |
| Purtscher's retinopathy | 2 (5.26%) |
| Terson's syndrome | 1 (2.63%) |
| Macular oedema | 2 (5.26%) |
| Optic atrophy | 5 (13.15%) |

***Table 3a***

| Orbital Injuries | |
|---|---|
| **Orbital Complications** | **Number of Patients** |
| Orbital fracture | 3 (7.89%) |
| Orbital haematoma | 2 (5.26%) |
| Emphysema of orbit | 1 (2.63%) |

***Table 3b***

| Neuro-Ophthalmic Manifestations | |
|---|---|
| **Isolated Nerve Palsies** | **Number of Patients** |
| Pupillary abnormalities | 19 (50%) |
| Optic neuropathy | 5 (13.15%) |
| Oculomotor nerve palsy | 1 (2.63%) |
| Lower motor neuron facial palsy | 4 (10.52%) |
| Upper motor neuron facial palsy | 1 (2.63%) |
| Multiple cranial nerve palsies | 4 (10.52%) |
| **Supranuclear Movement Disorder** | **Number of Patients** |
| Bilateral internuclear ophthalmoplegia | 1 (2.63%) |
| Skew deviation | 1 (2.63%) |
| Horizontal gaze palsy | 1 (2.63%) |

***Table 3c***

Neuro-ophthalmic manifestations were seen in 22 patients (57.89%). The commonest neuro-ophthalmic sign observed was pupillary abnormalities seen in 19 patients (50%). Cranial nerve palsies were seen in 15 patients (39.47%). Of these, isolated cranial nerve palsies were seen in 11 patients (28.94%). Amongst the isolated cranial nerve palsies, optic neuropathy was the commonest seen in 5 patients (13.15%), oculomotor neuropathy in 1 patient (2.63%), lower motor neuron facial palsy in 4 patients (10.52%), upper motor neuron facial palsy in 1 patient (2.63%) and multiple cranial palsies were observed in 4 patients (10.52%).

Supranuclear movement disorders were seen in 3 patients (7.89%). Of these, bilateral internuclear ophthalmoplegia was seen in 1 patient (2.63%), skew deviation in 1 patient (2.63%), horizontal gaze palsy in 1 patient (2.63%).

## DISCUSSION

Neuro-ophthalmic evaluation is challenging in head injury patients with reduced consciousness or coexisting injuries. This study has observed the ocular findings in acute stage of head injury. These included physical ocular trauma, orbital fracture and neuro-ophthalmic findings. The eye is innervated by half of cranial nerves and 38% of all fibres in central nervous system are concerned with visual function, so clinical findings of neuro-ophthalmic interest are frequently noted with head injury.[8]

The incidence of cranial nerve injury in craniocerebral trauma varies between 5-23%. Cranial nerves are injured before, during or after their passage through skull. In addition to and following the immediate effect of injury, some of the cranial nerves maybe damaged by complications such as reaction at fracture site, increased intracranial pressure or meningitis.

Head injury is a common cause of death and major disabilities in trauma patients. Eye is frequently injured due to proximity of eye to head as well due to neural connections between eye and brain. Many theories have been proposed as to how eye is injured in TBI. In penetrating injury, there may be physical damage to visual pathway cortex. In closed head injury, displacement, stretching and shearing forces damage areas of brain including those associated with vision.

There has been scanty documentation regarding ocular complications in head injury. A number of potential eye injuries maybe escaping ophthalmological assessment. Early diagnosis of visual problems after TBI is essential to maximise the overall rehabilitation potential.

In our study, ocular manifestations were seen in 35.18%. Of them, 63.15% had uniocular manifestation and 36.84% showed bilateral ocular manifestation. Majority of patients in our study were males and were in 20-30 years age group. This was similar observation in studies by TO Odebode et al[9] (47.36%) in Nigeria, Van Stavern et al,[10] Kulkarni et al[11] (62%), Sharma B et al[12] (67.4%). This prominence of head injuries in young adult male population could be due to their active outdoor and travelling lifestyle.

Road traffic accidents were implicated as the commonest mode of head injury in 84% of patients in our study. This was the commonest cause of injury in studies by TO Odebode et al[9] (84.2%), Van Stavern et al[10] (59.8%), Kulkarni et al[11] (52.5%).

Of the craniocerebral lesions leading to ocular manifestations, intracranial haematomas were the leading cause of ocular complications in our study. This was the commonest intracranial abnormality reported in head injury patients by G. Van Stavern P et al[10] (62.1%).

Ophthalmic signs of neurological significance were seen in 22 patients (57.89%) in our study. Most commonly seen neuro-ophthalmic manifestation was pupillary abnormalities seen in 19 cases (50%). Hutchison's pupil was seen in 1 patient due to intracranial haematoma secondary to head injury with fracture of frontal bone. This haematoma corresponded to the side of dilated pupil. Bilaterally dilated fixed pupil was seen in 2 patients, which was due to brainstem injury. Bilaterally dilated pupil with sluggish reaction to light was seen in 1 patient in whom there was fracture of middle cranial fossa causing third nerve palsy. Pinpoint fixed pupil was seen in 1 patient due to fracture base of skull and pontine haemorrhage. There were 5 (13.15%) cases of traumatic optic neuropathy causing dilated pupil. All these patients sustained injury to forehead of which 4 patients showed fracture of frontal bone, 1 patient showed fracture of orbital roof. Traumatic mydriasis was seen in 3 patients.

Cranial nerve palsies were observed in 15 cases (39.47%), facial nerve palsy being the commonest nerve involved, LNM facial palsy in 4 patients (10.38%), UMN facial palsy (2.63%) in 1 patient was observed. In these patients, there was fracture of petrous temporal bone in 2 patients, temporoparietal fracture in 2 cases and fracture base of skull in 1 case. Of the cranial nerves, the facial nerve is most susceptible to injury due to its complex course to the temporal bone with proximity structures such as middle ear. Ocular motor nerve palsy was reported in 2 patients. In 1 patient, there was fracture floor of the orbit with fracture extending to superior orbital fissure. In 1 patient, it was Hutchinson's pupil due to subdural haemorrhage. Traumatic optic neuropathy was seen in 5/38 (13.15%) patients in our study. But, 0.01% was reported by Kulkarni et al,[11] 43% by Van Stavern et al,[10] 12/50 (21.05%) by To Odebode et al.[9] There were varied observations regarding cranial involvement in different studies. Third cranial nerve was the commonest nerve involved in study by Van Stavern et al.[10] Sixth nerve, the commonest nerve injured as reported by the To Odebode et al.[9] Our study reported lower incidence of ocular motor nerve involvement as compared to other studies due to the fact that all the other studies included patients referred for ophthalmic problems, even 12 months after initial head injury, whereas we limited our study to patients who presented with neuro-ophthalmic manifestations in acute stage of head injury.

Orbital complications were reported in 6 patients (15.78%). Orbital fractures were seen in 3 patients (7.89%). The commonest intraocular manifestation following soft tissue injury to the globe and adnexa included ecchymosis in 10 patients, which was the commonest ocular manifestation in our study (26.31%), subconjunctival haemorrhage in 4 patients (10.5%). This was a similar observation in studies by Sharma B et al[12] (51.85%, 44.44%), Kulkarni et al[11] (27%, 19%), To Odebode et al[9] (21/57, 17/57). In our study, none of the orbital fractures resulted in enophthalmos, strabismus or globe rupture. The association between fracture of skull orbit and face and ocular findings was not statistically significant. This could be due to the fact that our sample size is small.

Obtaining the relevant ophthalmological history and complete ocular examination of patients with TBI was limited due to altered conscious level of the patients. Clinical correlation of ophthalmic findings is important in early localisation of site of injury, ongoing assessment and management of patients with TBI.

## CONCLUSION

Cranial nerve paralysis results in psychological, functional and social disturbances. Rehabilitation constitutes an important aspect of treatment. Perseverance is required to diagnosis of cranial nerve injuries in the presence of severe head trauma. Predicting outcomes following TBI is an integrative and assimilative process of various preinjury, injury and post injury variables. Specific tests of optic nerve function such as contrast sensitivity, color vision, VEP, visual fields could not be carried out in the acute setting of this study. Pupillary signs are of grave importance in indicating the site and severity and prognosis of head injury. It aids in localising the site of supratentorial injuries, extradural, subdural, pontine lesions. Hutchison's pupil indicates progressive coning and need for emergency lifesaving intervention. Identifying these early would reduce the incidence of consequent morbidity and mortality.

This study reiterates the importance of detailed early ophthalmological assessment in correlation with an overall clinical assessment of patients of head injury in prognosticating outcomes. In patients who are sedated for reasons of irritability, ocular examination is the only key to assess clinical condition. Timely intervention of ophthalmologist is mandatory to prevent exposure keratitis, neurotrophic keratitis and traumatic optic neuropathy. Rehabilitation of head injury patients can be much more effective and fruitful if vision is good because visual system impacts all aspects of life. Therefore, in order to achieve best possible results after head injury, it is mandatory that neurosurgeon and ophthalmologist work in liaison for the benefit of the patients.

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