ORIGINAL ARTICLE

Ocular injuries in patients with major trauma

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Aim: To study the epidemiology of ocular injuries in patients with major trauma in the UK, determining the incidence and causes of ocular injuries, and their association with facial fractures.

Methods: A retrospective analysis of the Trauma Audit Research Network database from 1989 to 2004, looking at data from 39 073 patients with major trauma.

Results: Of the 39 073 patients with major trauma, 905 (2.3%) patients had associated ocular injuries and 4082 (10.4%) patients had a facial fracture (zygoma, orbit or maxilla). The risk of an eye injury for a patient with a facial fracture is 6.7 times as that for a patient with no facial fracture (95% confidence interval 5.9 to 7.6). Of the patients with major trauma and an eye injury, 75.1% were men, and the median age was 31 years. 57.3% of ocular injuries were due to road traffic accidents (RTAs).

Conclusion: The incidence of ocular injuries in patients with major trauma is low, but considerable association was found between eye injuries and facial fractures. Young adults have the highest incidence of ocular injury. RTAs are the leading cause of ocular injuries in patients with major trauma. It is vital that all patients with major trauma are examined specifically for an ocular injury.

Worldwide, an estimated 1.6 million people are blind as a result of eye injuries, and a further 19 million have monocular blindness or low vision due to eye trauma.¹ Eye injuries in association with major trauma are particularly important as these injuries have a high risk of threatening vision.² Even minor eye injuries can cause considerable morbidity³ and time lost from work.⁴

Eye injuries in association with major trauma can pose diagnostic difficulties, as patients with a reduced conscious level may not report visual symptoms, and assessment of the eye can be awkward in a supine patient. Eye injuries may be associated with facial injuries: in patients with periorbital haematomas and swelling, it may not be possible to see the eye properly at the initial examination. Treating life-threatening injuries will be the immediate priority in a patient with multiple injuries, but the potential for vision loss due to ocular trauma should not be forgotten.

Although penetrating eye injuries from road traffic accidents (RTAs) have decreased considerably after seatbelt legislation in 1983 and the introduction of laminated windscreens,^{5,6} little is known about the current epidemiology of ocular injuries in patients with major trauma in the UK. To investigate this group of patients, we performed a retrospective analysis of a UK trauma database, looking at the incidence of ocular injuries with major trauma, and their association with facial fractures.

METHODS

The Trauma Audit and Research Network (TARN; which includes 50% of trauma-receiving hospitals in England and Wales) collects data on patients attending participating hospitals, who sustain an injury resulting in immediate admission to hospital for ≥ 3 days, admission to an intensive care or a high-dependency unit, or death in 93 days. TARN excludes patients aged >65 years with an isolated fracture of the femoral neck or pubic ramus and those with single uncomplicated limb injuries. Patient information is recorded at the time of discharge. Details of TARN have been described previously.⁷

TARN classifies injuries using the Abbreviated Injury Scale,⁸ and records the anatomical severity of injuries using the Injury Severity Score (ISS). An ISS of 16 is predictive of a

mortality of about 10%, and this defines major trauma based on anatomical injury.^{9,10}

We used the TARN database to investigate the incidence and causes of eye injury in patients with major trauma. Major trauma was defined as ISS >15 . We analysed the data for all patients who had sustained an eye injury, injury to the second, third, fourth or sixth cranial nerve, or a facial fracture (maxilla, zygoma or orbit) between 1989 and 2004. Ethics committee approval was not required.

RESULTS

The TARN database recorded 208 007 patients between 1989 and 2004, of whom 39 073 had major trauma as defined earlier. Of these patients, 905 (2.3%) were recorded as having eye injuries. In this group, 75.1% were men and 24.8% were women, and the median age was 31 years. The median ISS was 26. Information on mortality was recorded for 74% of patients. Excluding patients in whom the outcome was unknown, 19.5% of patients died before discharge from hospital.

These 905 patients had 984 eye injuries (table 1). Blunt trauma was responsible for 952 (96.7%) injuries and 32 (3.3%) injuries were the result of penetrating trauma. The mortality of patients with eye avulsions and scleral injuries was higher than the mean mortality of patients with eye injuries at 23% and 25%, respectively, and the mortality of patients with optic nerve injuries was lower at 12%.

Table 2 shows the causes of the injuries; 57.3% of ocular injuries followed an RTA.

Of the 39 073 patients with major trauma, 4082 (10.4%) had a facial fracture (zygoma, orbit or maxilla), and 398 (9.8%) of these patients also had an eye injury. Of the 34 991 patients without a facial fracture, 507 (1.4%) patients had an eye injury (table 3). The risk of an eye injury for a patient with a facial fracture is 6.7 times that for a patient with no facial fracture (95% confidence interval (CI) 5.9 to 7.6).

Abbreviations: RTA, road traffic accidents; TARN, Trauma Audit and Research Network

Table 1 Ocular injuries in patients with major trauma

Ocular injury	Number of injuries	Percentage
Tear duct	3	0.3
Conjunctiva	127	12.9
Cornea	305	31.0
Uvea	2	0.2
Iris	5	0.5
Vitreous	15	1.5
Retina	58	5.9
Choroid	3	0.3
Sclera	90	9.1
Eye avulsion	40	4.1
Eye (not specified further)	80	8.1
Optic nerve	130	13.2
Oculomotor nerve	71	7.2
Trochlear nerve	12	1.2
Abducens nerve	43	4.4
Total	984	100

DISCUSSION

In this study, only a small proportion of patients with major trauma have associated ocular injuries (2.3%). This is lower than that found in previous studies. A study in Washington, DC, in 1982–88 found that 13.5% of patients with major trauma had associated ocular injuries.¹¹ The use of seat belts during the study period was not recorded, although it is likely to have been low (<http://www.nhtsa.dot.gov>) and this will have contributed to the higher percentage of eye injuries. A more recent Australian study (1990–7) found the incidence of injuries affecting the eye, adnexae, orbit and anterior visual pathways in patients with major trauma was 16%.² Our lower incidence of ocular injury may be at least partly explained by different inclusion criteria. Both of these studies included adnexal injuries, whereas we only included tear duct lacerations. We counted orbital fractures as facial fractures, unlike the Australian study which grouped them with ocular injuries.²

We recognise that this study may underestimate the incidence of eye injuries, because relatively minor eye injuries may not have been reported to the TARN or may even be missed in patients with major, life-threatening trauma. Injuries of the eyelids do not have a specific Abbreviated Injury Scale code and are therefore not included. Foreign bodies are not coded (but the injuries that they cause are coded).

In this series, the most common ocular injuries are (in decreasing order) to the cornea, optic nerve, conjunctiva and sclera. Facial fractures are associated with ocular injury, although most patients with an eye injury do not have a facial fracture. Patients with a fracture of the maxilla, zygoma or orbit are seven times as likely to have sustained an eye injury as patients without a facial fracture. Maxilla fractures are most common, but the proportion of eye injuries associated with each fracture was similar.

An association between facial fractures and visual impairment has been well documented. Several papers report that the highest incidence of severe ocular injury occurs in patients with mid-facial fractures caused by RTAs, although some of the populations studied had low seatbelt usage.^{12–14} Al-Qurainy *et al*¹² found that most patients with mid-facial fractures had evidence of an eye injury, and 27% sustained a moderate or severe eye injury. Impairment in visual acuity was the most sensitive single predictor of ocular injury. Other factors associated with an increased risk of ocular injury in the context of facial injuries can be remembered by the acronym BAD ACT: Blow-out fracture, Acuity, Diplopia, Amnesia, Comminuted Trauma.¹⁵

Table 2 Cause of ocular injury in patients with major trauma

Cause of ocular injury	Number of patients	Percentage
Road traffic accident	519	57.3
Fall >2 m	110	12.2
Fall <2 m	60	6.6
Assault	95	10.5
Non-accidental injury	40	4.4
Other	81	9.0
Total	905	100

The optic nerve was the most frequently injured of the cranial nerves associated with the eye. This is important, as optic nerve injuries carry a poor visual prognosis; one third of patients in the International Optic Nerve Trauma Study had a final visual acuity of hand movements or worse in the affected eye.¹⁶ Optic nerve injuries were associated with a facial fracture in two thirds of cases. A marked association between orbital fracture and optic nerve injuries in patients with major trauma has been reported previously.² The incidence of optic nerve injury in patients with a facial fracture was 2.1%, which is similar to that reported by Al-Qurainy *et al*¹² in their series of patients with mid-facial fractures.

The TARN database classifies injuries according to anatomical location rather than clinical diagnosis, making it difficult to draw conclusions about the absolute numbers of severe eye injuries. Penetrating trauma refers to the mode of injury rather than being a clinical diagnosis. However, a proportion of eye injuries in patients with major trauma, such as eye avulsions, scleral injuries and optic nerve injuries, are highly likely to be severe. Our data suggest that patients with an eye avulsion or scleral injury may have a higher mortality when compared with the mean mortality for patients with eye injuries and major trauma, but the outcome data were incomplete and so we cannot confirm this reliably.

Despite improvements after seatbelt legislation,^{5, 6} RTAs still cause a large proportion of ocular injuries in patients with major trauma (57.3% in our series). This is similar to the US study where motor vehicle crashes accounted for 52.1% of injuries.¹¹ Some evidence indicates that eye injuries in RTAs are increasing in the US.¹⁷ This has been attributed to frontal air bags, which, while reducing the risk of fatal injuries, may increase the risk of eye injury. McGwin and Owsley¹⁷ reported a twofold risk of eye injury with frontal airbag deployment, although most injuries were to the eyelids. It is possible that air bags increase the overall risk of eye injury, while at the same time reducing the number of severe eye injuries.¹⁸ However, an increasing number of patients are undergoing corneal surgery, including refractive surgery, and there are concerns that weakness of the cornea after a surgery may make these patients more prone to severe eye injuries.^{19, 20}

Table 3 Patients with major trauma, facial fractures and the association with ocular injury

Facial fracture	Total	Ocular injury	
		Number	Percentage
Maxilla	2039	215	10.5
Orbit	1848	201	10.9
Zygoma	1582	162	10.2
All facial fractures	4082	398	9.8
No facial fracture	34 991	507	1.4

Some patients had >1 facial fracture and some patients had >1 eye injury.

Although numbers of such patients are small, this may also contribute to an increase in eye injuries. It is important to note that air bag design can vary, potentially altering injury patterns. Air bags in the US have traditionally inflated at higher pressures than their UK counterparts as they are designed to protect occupants wearing and not wearing seat belts.²¹ Lower-power air bags have been introduced in the US since 1998 in an effort to reduce the number of airbag-induced injuries (<http://www.nhtsa.dot.gov>).

Major trauma and associated ocular injuries are three times more common in men as in women, and young adults are at greatest risk. Visual impairment in the active years of life will be particularly devastating, delaying rehabilitation and having serious vocational and economic consequences.¹

Early recognition of eye injuries in patients with major trauma is important as timely treatment of injuries, such as retinal detachments and intraocular foreign bodies, may save vision.²² All patients with major trauma should be examined for evidence of eye injury, with particular attention to patients with facial injuries and those involved in RTAs. Visual acuity should be measured where possible, and the pupils and ocular movements should be examined. Computed tomographic scans of the orbit can be a helpful adjunct to clinical examination. They are especially useful for diagnosing orbital fractures and optic nerve injuries, but can also show ocular soft-tissue injuries.²³

The TARN database has provided current data on the epidemiology of eye trauma in the UK. It is worrying that RTAs still have a major contribution to eye injuries in patients with major trauma, and the role of airbag deployment as a possible causative factor requires further study. If we can more clearly understand the mechanisms by which ocular injuries occur in major trauma, we can ensure that eye injuries are not only detected and treated promptly but also prevented.

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REFERENCES

- 1 **Négrel A-D**, Thylefors B. The global impact of eye injuries. *Ophthalmic Epidemiology* 1998;**5**:143–69.
- 2 **Poon A**, McCluskey PJ, Hill DA. Eye injuries in patients with major trauma. *J Trauma* 1999;**46**:494–9.
- 3 **Eke T**, Morrison DA, Austin DJ. Recurrent symptoms following traumatic corneal abrasion: prevalence, severity, and the effect of a simple regimen of prophylaxis. *Eye* 1999;**13**:345–7.
- 4 **Schein OD**, Hibberd PL, Shingleton BJ. The spectrum and burden of ocular injury. *Ophthalmology* 1988;**95**:300–5.
- 5 **Hall NF**, Denning AM, Elkington AR, *et al.* The eye and the seatbelt in Wessex. *Br J Ophthalmol* 1985;**69**:317–19.
- 6 **Johnston PB**, Armstrong MFJ. Eye injuries in Northern Ireland two years after seat belt legislation. *Br J Ophthalmol* 1986;**70**:460–2.
- 7 **Lecky FE**, Woodford M, Bouamra O, *et al.* Lack of change in trauma care in England and Wales since 1994. *Emerg Med J* 2002;**19**:520–3.
- 8 **Association for the Advancement of Automotive Medicine**. *The Abbreviated Injury Scale 1998 Revision*. Barrington, Illinois: AAAM, 1998.
- 9 **Boyd CR**, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score. *J Trauma* 1987;**27**:370–8.
- 10 **Yates DW**. ABC of major trauma. Scoring systems for trauma. *BMJ* 1990;**301**:1090–4.
- 11 **Sastry SM**, Paul BK, Bain L, *et al.* Ocular trauma among major trauma victims in a regional trauma centre. *J Trauma* 1993;**34**:223–6.
- 12 **Al-Quraiby A**, Stassen LFA, Dutton GN, *et al.* The characteristics of midfacial fractures and the association with ocular injury: a prospective study. *Br J Oral Maxillofac Surg* 1991;**29**:291–301.
- 13 **Jayamanne DGR**, Gillie RF. Do patients with facial trauma to the orbito-zygomatic region also sustain significant ocular injuries? *J R Coll Surg Edinb* 1996;**41**:200–3.
- 14 **Ashar A**, Kovacs A, Khan S, *et al.* Blindness associated with midfacial fractures. *J Oral Maxillofac Surg* 1998;**56**:1146–50.
- 15 **Al-Quraiby A**, Titterton DM, Dutton GN, *et al.* Midfacial fractures and the eye: the development of a system for detecting patients at risk of eye injury. *Br J Oral Maxillofac Surg* 1991;**29**:363–7.
- 16 **Levin LA**, Beck RW, Joseph MP, *et al.* The treatment of traumatic optic neuropathy—The International Optic Nerve Trauma Study. *Ophthalmology* 1999;**106**:1268–77.
- 17 **McGwin G**, Owsley C. Risk factors for motor vehicle collision-related eye injuries. *Arch Ophthalmol* 2005;**123**:89–95.
- 18 **Duma SM**, Jernigan MV, Stitzel JD, *et al.* The effect of frontal air bags on eye injury patterns in automobile crashes. *Arch Ophthalmol* 2002;**120**:1517–22.
- 19 **Maharshak I**, Bourla D, Grinbaum A, *et al.* Airbag-induced bilateral corneal graft dehiscence. *Cornea* 2005;**24**:110–1.
- 20 **Norden RA**, Perry HD, Donnenfield ED, *et al.* Air bag-induced corneal flap folds after laser in situ keratomileusis. *Am J Ophthalmol* 2000;**130**:234–5.
- 21 **Wallis LA**, Greaves I. Injuries associated with airbag deployment. *Emerg Med J* 2002;**19**:490–3.
- 22 **MacCumber MW**, De Juan Jr E. Progress in the treatment of posterior segment trauma. *Curr Opin Ophthalmol* 1994;**5**:44–9.
- 23 **Lee H**, Jilani M, Frohman L, *et al.* CT of orbital trauma. *Emergency Radiology* 2004;**10**:168–72.
- 24 **Patel HC**, Bouamra O, Woodford M, *et al.* Trends in head injury outcome from 1989 to 2003 and the effect of neurosurgical care: an observational study. *Lancet* 2005;**366**:1538–44.