Original Article

Blunt facial trauma as a predictor of ocular injury in polytrauma patients: a cross-sectional study

Aziz Rasooli [1], Mohammad Sedaghat [2], Meisam Sharifi [1], Mahdi Ebrahimi [1] and Mohammad Vaseie [1]

[1] *Emergency Medicine Department, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran*
[2] *Emergency Medicine Department, School of Medicine, Shahed University, Tehran, Iran*

ABSTRACT

Background: Ocular injury is a clinically significant complication of facial trauma, yet its burden and predictors in polytrauma remain undercharacterized. Understanding these associations is essential for optimizing early ophthalmic assessment, particularly in settings with high rates of road traffic injuries.

Methods: This retrospective cross-sectional study included polytrauma patients (injury severity score [ISS] >15) admitted to a tertiary trauma center over a five-year period. Eligible patients sustained blunt injuries and underwent standardized craniofacial CT and ophthalmic assessment. Facial trauma was identified using International Classification of Diseases, Tenth Revision (ICD-10) codes and radiologic confirmation. Ocular injuries were classified according to Birmingham Eye Trauma Terminology System criteria. Data on demographics, injury mechanisms, and clinical findings were extracted for analysis.

Results: Among 7456 polytrauma patients (mean age 38.7 years), 68.2% (5085) were male and 1491 (20.0%) had blunt facial trauma. Ocular injury occurred in 20.9% (n = 312) of patients with facial trauma versus 4.2% (n = 251) without. Midface fractures were strongly associated with orbital injury, whereas mandibular fractures were associated with ocular adnexal trauma (both $P < 0.001$). The most frequent ocular findings were orbital fracture (n = 312/142, 45.5%), subconjunctival hemorrhage (n = 312/88, 28.2%), hyphema (n = 312/46, 14.7%), and globe rupture (n = 312/12, 3.8%). Subgroup analyses further demonstrated that road traffic accidents (RTAs) mechanism conferred more than twice the risk of ocular injury compared with other mechanisms. Multivariate logistic regression analysis identified blunt facial trauma (adjusted odds ratio [OR], 3.82; 95% confidence interval [CI], 2.91–5.02; $P < 0.001$), RTAs (adjusted OR, 2.14; 95% CI, 1.67–2.75; $P < 0.001$), male sex (adjusted OR, 1.45; 95% CI, 1.12–1.88; $P = 0.005$), higher ISS (adjusted OR, 1.06 per point; CI, 95%, 1.03–1.09; $P < 0.001$), and increasing age (adjusted OR, 1.02 per year; 95% CI, 1.00–1.04; $P < 0.005$) as independent predictors of ocular injury. Baseline visual impairment (VA < 20/40) was present in 38.2% of affected patients. The incidence of facial trauma showed a slight upward trend from 2021 to 2025, albeit not statistically significant ($P > 0.05$).

Conclusions: Ocular injury represents a substantial and clinically important component of polytrauma involving the face. Patients with blunt facial trauma, particularly those with RTAs mechanisms, are at markedly elevated risk of ocular injury. Age, sex, fracture pattern, injury mechanism, and overall trauma severity are key determinants of ocular morbidity, underscoring the need for integrated maxillofacial-ophthalmic management strategies within trauma care systems.

KEYWORDS

multiple traumas, polytrauma, injury severity scores, ISS score, glasgow coma scale, faces, facial injury, reduced vision, traffic accident, incidences

Correspondences: Mohammad Vaseie, Emergency Medicine Department, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran. Email: vaseiem@yahoo.com. ORCID iD: https://orcid.org/0000-0002-2762-7298.

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INTRODUCTION

High-energy trauma due to motor vehicle collisions commonly affects the head and face, with facial trauma seen in 15%–24% of polytrauma patients [1-3]. Ocular injury is common after facial trauma because the close orbital-facial anatomy makes upper-face and forehead injuries particularly liable to cause damage ranging from minor soft-tissue laceration to globe rupture [4-6].

In Iran, where road accident trauma admissions are a leading cause of injury [7, 8], ocular and facial trauma is a heavy clinical burden. There is a frequent association of eye injuries with facial trauma, varying in severity, mechanism of injury, and thoroughness of examination [9-11].

Limited studies report links between facial trauma and eye injury in patients suffering polytrauma, revealing a high risk for sight-threatening injuries [12, 13]. Orbital fractures are common and potentially impact vision in polytrauma patients [12]. Greater elucidation of these patterns may maximize our management of the trauma patient, particularly in regions where road traffic injury is prevalent and socioeconomic issues further increase burden of injury [14-16].

We sought to establish the incidence of blunt facial injury among polytrauma patients in Sina Hospital, a major trauma center in Tehran, and to determine whether facial injury was independently associated with ocular trauma. We aimed to characterize injury patterns and identify risk factors relevant to clinical practice. Where available, we reported initial visual acuity to indicate early functional impact.

METHODS

This retrospective cross-sectional study analyzed de-identified electronic health records of consecutive polytrauma patients (injury severity score [ISS] >15 [17]) admitted to Sina Hospital, a tertiary educational trauma center affiliated with Tehran University of Medical Sciences, between March 2021 and March 2025. The study protocol was approved by the Institutional Review Board of Tehran University of Medical Sciences (IR.TUMS.SINAHOSPITAL.REC.1401.118). All procedures conformed to the tenets of the Declaration of Helsinki. At hospital admission, all patients provided written informed consent for clinical evaluation and treatment as part of routine care. In accordance with institutional policy at educational hospitals, patients also signed a general consent permitting the use of de-identified medical information for educational and research publication purposes.

Inclusion criteria comprised polytrauma patients aged 18–65 years who sustained blunt injuries—such as those resulting from road traffic accidents (RTAs), falls, assaults, or other blunt mechanisms—with complete medical records available for review. Exclusion criteria included penetrating trauma, isolated head injury, incomplete or poor-quality documentation, and absence of craniofacial computed tomography (CT) imaging. All eligible patients underwent standardized initial assessment in accordance with institutional trauma management protocols.

Facial trauma was classified according to the International Classification of Diseases, Tenth Revision (ICD-10) diagnosis code for maxillofacial fracture (S02.0–S02.9), soft-tissue injuries of the head such as face and scalp (S00.0–S00.9), or orbital fracture (S05.1–S05.9) [18]. Diagnoses were verified on craniofacial CT scans.

Polytrauma patients with clinical or paraclinical evidence suggestive of ocular involvement, including findings on craniofacial CT or other imaging studies, or clinical suspicion of ocular injury, were referred to the ocular emergency service for comprehensive ophthalmic evaluation. Anterior segment examination was performed using a slit-lamp biomicroscope (Haag-Streit BM 900; Haag-Streit AG, Bern, Switzerland). Fundus evaluation was conducted with a slit-lamp and a noncontact +90 D or +78 D Volk lens (Volk Optical, Inc., Mentor, OH, USA). When feasible, baseline visual acuity was assessed using a Snellen chart (Nidek Co., Ltd., Gamagori, Aichi, Japan), and intraocular pressure was measured with a Goldmann applanation tonometer (AT-900; Haag-Streit AG, Bern, Switzerland). The final diagnosis and etiology of ocular injury were retrieved from emergency department ophthalmology consultation notes completed by the on-call physician resident. In cases of diagnostic uncertainty, clinical findings were reviewed and verified by a senior faculty ophthalmologist, who confirmed the final diagnosis and cause of injury. Ocular trauma was staged according to the Birmingham Eye Trauma Terminology System into closed-globe trauma (contusion, lamellar laceration), open-globe trauma (rupture, penetration) [19, 20], and adnexal trauma [21, 22]. Staging was based on documented ophthalmologic consultation, slit-lamp examination, fundoscopy, and imaging when available.

Demographic characteristics (age, sex), mechanism of injury, ISS, Glasgow Coma Scale (GCS) score [23], and ocular findings on initial examination—such as orbital fractures, subconjunctival hemorrhage, hyphema, and globe rupture—were extracted. When available, baseline visual acuity was recorded to evaluate immediate functional impact.

All data were entered into and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as means with standard deviations (SDs), and categorical variables as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Between-group comparisons used independent *t*-tests for continuous variables and chi-square tests for categorical variables. Multivariate logistic regression was employed to examine the association between facial trauma and ocular injury, adjusting for age, sex, mechanism of injury, ISS, and GCS; adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Model fit was evaluated using the Hosmer-Lemeshow test ($P > 0.05$ indicating acceptable fit), and multicollinearity was assessed using variance inflation factors (VIF < 5 considered acceptable). Subgroup analyses were stratified by fracture location (mandibular vs. midface) and injury mechanism (road traffic accidents [RTAs], falls, assaults, or other blunt mechanisms). A sensitivity analysis excluding 428 patients (5.7%) with incomplete ophthalmologic records addressed potential bias from underreporting of minor injuries. Temporal trends in the yearly incidence of facial trauma among polytrauma admissions were evaluated using the Cochran-Armitage trend test. Statistical significance was set at $P < 0.05$.

RESULTS

The study included 7456 polytrauma patients with a mean (SD) age of 38.7 (12.4) years; 68.2% (5085) were male. Facial trauma occurred in 1491 patients (20.0%). RTAs were the predominant mechanism (n = 4652, 62.4%), followed by falls (n = 1364, 18.3%), assault (n = 902, 12.1%), and other causes (n = 538, 7.2%). Baseline demographic characteristics for all participants and for those with and without facial trauma are shown in Table 1.

Patients with facial trauma were more often male (70.8% [n = 1056] vs 67.5% [n = 4029], $P < 0.005$) and had a higher mean (SD) ISS (24.6 [8.1] vs 19.3 [7.2], $P < 0.001$) and lower GCS scores (11.2 [3.4] vs. 13.5 [2.9], $P < 0.001$) compared with those without facial trauma (Table 1). Ocular injury was also significantly more prevalent in the facial trauma group than in the non-facial trauma group (312/1491 [20.9%] vs 251/5965 [4.2%], $P < 0.001$) (Table 1).

In the facial trauma group, the most frequent ocular injuries were orbital fractures (n = 312/142, 45.5%), subconjunctival hemorrhage (n = 312/88, 28.2%), hyphema (n = 312/46, 14.7%), and globe rupture (n = 312/12, 3.8%). In the subgroup analysis restricted to polytrauma patients with blunt facial trauma, midface fractures were significantly associated with orbital injury ($P < 0.001$), whereas mandibular fractures were significantly associated with ocular adnexal injury ($P < 0.001$). Patients injured in RTAs had more than twice the risk of ocular injury compared with those injured by other mechanisms (OR, 2.31; 95% CI, 1.78–2.99; $P < 0.001$).

Among the 563 patients with ocular trauma, baseline visual acuity data were available for 482 (85.6%). Vision impairment (baseline visual acuity worse than 20/40) was observed in 184 patients (38.2%), indicating substantial functional deficit.

Multivariate logistic regression analysis showed that blunt facial trauma independently predicted ocular injury (adjusted OR, 3.82; 95% CI, 2.91–5.02; $P < 0.001$). Additional independent predictors included increasing age (adjusted OR, 1.02 per year; 95% CI, 1.00–1.04; $P < 0.005$), male sex (adjusted OR, 1.45; 95% CI, 1.12–1.88; $P = 0.005$), RTA injury mechanism (adjusted OR, 2.14; 95% CI, 1.67–2.75; $P < 0.001$), and higher ISS (adjusted OR, 1.06 per point; 95% CI, 1.03–1.09; $P < 0.001$). The model demonstrated good fit (Hosmer-Lemeshow $P = 0.214$) and no concerning multicollinearity (all VIFs < 3.2).

Sensitivity analysis showed that excluding the 428 patients (5.7%) with missing ophthalmologic data did not materially alter the results (adjusted OR, 3.78; 95% CI, 2.85–4.99; $P < 0.001$), thereby strengthening the robustness of our preliminary findings. The yearly incidence proportion of facial trauma among polytrauma admissions rose slightly from 18.6% in 2021 to 21.3% in 2025, with an overall incidence proportion of 20.0% across the five-year period. (Table 3), although this trend did not reach statistical significance ($P = 0.078$).

Table 1. Demographic and clinical characteristics of study participants

Variable	Total (n = 7456)	Facial Trauma (n = 1491)	Non-Facial Trauma (n = 5965)	*P*-value
Age (y), Mean ± SD	38.7 ± 12.4	39.1 ± 12.7	38.6 ± 12.3	0.124
Sex (Male / Female), n (%)	5085 (68.2) / 2371 (31.8)	1056 (70.8) / 435 (29.2)	4029 (67.5) / 1936 (32.5)	**0.008**
ISS (score), Mean ± SD	20.8 ± 7.8	24.6 ± 8.1	19.3 ± 7.2	**< 0.001**
GCS (score), Mean ± SD	12.8 ± 3.2	11.2 ± 3.4	13.5 ± 2.9	**< 0.001**
Ocular injury, n (%)	563 (7.5)	312 (20.9)	251 (4.2)	**< 0.001**
Injury mechanism, n (%)				**< 0.001**
RTAs	4652 (62.4)	1042 (69.9)	3610 (60.5)	
Fall	1364 (18.3)	233 (15.6)	1131 (19.0)	
Assault	902 (12.1)	151 (10.1)	751 (12.6)	
Other	538 (7.2)	65 (4.4)	473 (7.9)	

Abbreviations: n, number of participants; y, years; SD, standard deviation; ISS, Injury Severity Score [17]; GCS, Glasgow Coma Scale [23]; RTAs, road traffic accidents.

Table 2. Multivariate logistic regression for predictors of ocular injury

Variable	Adjusted OR (95% CI)	*P*-value	B	SE	Wald Statistic
Blunt facial trauma	3.82 (2.91–5.02)	**< 0.001**	1.340	0.139	92.81
Age (per year)	1.02 (1.00–1.04)	**0.032**	0.020	0.009	4.58
Male sex	1.45 (1.12–1.88)	**0.005**	0.372	0.132	7.92
RTA mechanism	2.14 (1.67–2.75)	**< 0.001**	0.762	0.127	35.92
ISS (per unit)	1.06 (1.03–1.09)	**< 0.001**	0.058	0.015	15.01
GCS (per unit)	0.97 (0.94–1.00)	0.054	-0.030	0.016	3.70

Abbreviations: OR, odds ratio; CI, confidence interval; B, coefficient; SE, standard error; RTA, road traffic accident; ISS, Injury Severity Score [17]; GCS, Glasgow Coma Scale [23]. * Reference categories: Non-facial trauma, Female sex, Non-RTA mechanism.

Table 3. Annual incidence proportion of facial trauma among polytrauma patients (2021–2025)

Year	Total polytrauma patients (n)	polytrauma patients with facial trauma (n)	Incidence (%)
2021	1499	279	18.6
2022	1463	283	19.3
2023	1478	295	20.0
2024	1474	305	20.7
2025	1542	329	21.3
Total	7456	1491	20.0

Abbreviations: n, number of participants; %, percentage.

DISSCUSSION

The present study demonstrates that ocular injury is a substantial and clinically significant component of polytrauma involving the face. Among 7456 polytrauma patients, 20.0% sustained blunt facial trauma, and ocular injury occurred in 20.9% of these cases—fivefold higher than in those without facial trauma. Midface fractures were strongly associated with orbital injury, whereas mandibular fractures predominantly involved ocular adnexal injury. RTAs emerged as the leading mechanism and an independent predictor of ocular trauma, alongside blunt facial trauma, increasing age, male sex, and greater injury severity. Baseline visual impairment was present in 38.2% of patients with ocular injury, underscoring the functional burden and the need for routine ophthalmic evaluation in polytrauma patients with concomitant facial injury.

Guly et al. [13] analyzed 39073 patients with major trauma (ISS > 15) in the UK over a 15-year period, 4082 (10.4%) of them with facial fractures; in the present 5-year study of 7456 polytrauma patients, 1491 (20.0%) sustained blunt facial trauma. Although the overall incidence of ocular injury in their cohort was lower (905/39073; 2.3%) than in ours (563/7456; 7.5%), both studies demonstrated a strong association between facial trauma and ocular injury. They reported that patients with facial fractures were 6.7 times more likely to sustain ocular injury than those without fractures (95% CI, 5.9–7.6), consistent with our finding that ocular injury is markedly more common among patients with facial trauma (20.9% [n = 312] vs 4.2% [n = 251]) and with our identification of blunt facial trauma as an independent predictor (adjusted OR, 3.82; 95% CI, 2.91–5.02). Comparable demographic patterns were observed in both datasets, with RTAs constituting the leading mechanism of ocular trauma (Guly et al.: 57.3% [n = 519]; current study: 62.4% [n = 4652]). Together, these findings highlight the consistent and clinically significant association between facial injury and ocular morbidity across large trauma populations, underscoring the importance of detailed ocular assessment in polytrauma care.

Our findings align with several key observations reported by Zhou et al. [24], who examined ocular trauma in 1131 patients with maxillofacial fractures over a 10-year period. The rate of ocular injury in our facial-trauma cohort (20.9%; 312/1491) was comparable to their reported 18.5% (209/1131), despite substantial differences in population structure and injury severity. Consistent with their results, we identified male sex as an independent predictor of ocular injury (Zhou et al.: OR, 1.542; 95% CI, 1.019–2.334; $P = 0.041$; current study: OR, 1.45; 95% CI, 1.12–1.88; $P = 0.005$), as well as motor vehicle-related mechanisms (Zhou et al.: OR, 2.243; 95% CI, 1.131–4.450; $P = 0.021$; current study: OR, 2.14; 95% CI, 1.67–2.75; $P < 0.001$), with both datasets demonstrating a similar twofold increase in risk. Zhou et al. [24] also reported the highest risk among individuals aged 30–39 years (OR, 1.852; $P < 0.001$), whereas our study found increasing age to be an independent predictor (OR, 1.02 per year). Both studies demonstrated a consistent anatomic patterning of risk: midfacial fractures were strongly associated with orbital injury. Odd ratios reported by Zhou et al. were 10.232 and 12.389 for midfacial and multiple midfacial fractures, respectively (both $P < 0.001$) [24], while mandibular fractures carried a markedly lower risk of 0.151 and 0.035 for single mandibular and multimandibular fractures, respectively (both $P < 0.001$) [24]. In our subgroup analysis restricted to polytrauma patients with blunt facial trauma, midface fractures were significantly associated with orbital injury, whereas mandibular fractures were more often associated with ocular adnexal trauma.

Eng et al. [25] aimed to characterize ocular injuries associated with midface fractures and evaluated 773 such patients at a Level I trauma center [25]. In contrast, the present study examined a broader polytrauma population (n = 7456), 1491 (20.0%) of whom sustained blunt facial trauma involving both midface and mandibular injuries. Despite substantial differences in study populations and scope, both investigations evidence a high burden of ocular morbidity associated with facial trauma. Eng et al. [25]reported that 36% of patients had minor ocular injuries and 10.5% had major injuries, whereas in our cohort 20.9% of patients with facial trauma had ocular involvement, including hyphema (14.7%) and globe rupture (3.8%)—injuries consistent with the "major injury" category defined by Eng et al. [25] Mechanisms of injury also differed markedly, whereby Eng et al. [25] observed assault as the predominant etiology (63.8%) while RTAs were the leading mechanism in our population (62.4%). Nonetheless, both studies found mechanism to be a significant determinant of ocular injury risk. Eng et al. [25] reported ocular involvement in 52.6% of gunshot wounds, 28.8% of assaults, and 16.7% of motor vehicle collisions, and our study identified RTAs as an independent predictor (adjusted OR, 2.14; 95% CI, 1.67–2.75). They also highlighted the high frequency of ocular injury in orbital floor and zygomaticomaxillary complex fractures. Our findings indicated that midface fractures were strongly associated with orbital injury, whereas mandibular fractures were predominantly linked to ocular adnexal trauma. Together, these findings highlight the need for routine ophthalmologic assessment in patients with facial trauma and support the broader conclusion that injury mechanism and fracture pattern are determinants of ocular morbidity across diverse trauma settings.

Panshak et al. [26] conducted a hospital-based, cross-sectional study of 67 patients with maxillofacial trauma in North Central Nigeria, aiming to determine the prevalence, patterns, and risk factors of ophthalmic injury. In contrast, the present study examined a substantially larger polytrauma population (n = 7456), 1491 (20.0%) of whom sustained blunt facial trauma. Despite differences in sample size, study design, and injury severity, both investigations demonstrate a strong association between facial trauma and ocular involvement. Panshak et al. [26] reported an ophthalmic injury prevalence of 77.6%, considerably higher than the 20.9% observed among patients with facial trauma in the current study; however, their cohort consisted exclusively of maxillofacial trauma patients, whereas our study included a heterogeneous polytrauma population. In both studies, young adult males constituted the majority of affected patients (Panshak et al.: 79.1%, mean age 31.9 years; current study: 68.2%, mean age 38.7 years). Differences in reported severity reflect variations in case mix: Panshak et al. [26] noted globe rupture as the leading cause of visual impairment, whereas our cohort showed broader injury distributions with orbital fractures in 45.5%, subconjunctival hemorrhage in 28.2%, hyphema in 14.7%, and globe rupture in 3.8% of patients. Collectively, both studies emphasize the high burden of ocular injury in facial trauma and underscore the necessity of routine ophthalmologic evaluation across diverse trauma populations.

The current study benefits from a large, well-defined polytrauma cohort, standardized imaging and ophthalmic evaluation, and robust multivariable modeling with sensitivity analyses that strengthen confidence in the findings. The integration of fracture patterns, injury mechanisms, and visual outcomes provides clinically actionable detail rarely captured in polytrauma research. Limitations include the retrospective design, potential underdocumentation of minor ocular injuries, incomplete baseline visual acuity data, lack of follow-up to determine final visual outcomes or complications, and the single-center setting, which may limit generalizability. Future work should incorporate prospective, protocol-driven ophthalmic assessments, include long-term visual and quality-of-life measures, and evaluate decision-support tools to improve triage and early ophthalmology consultation in polytrauma care.

CONCLUSIONS

The findings of this study demonstrate that ocular injury is a frequent and clinically significant component of polytrauma involving the face. Blunt facial trauma independently conferred a markedly elevated risk of ocular injury and remained a strong predictor alongside RTAs, increasing age, male sex, and greater injury severity. Midface fractures showed a strong association with orbital involvement, whereas mandibular fractures were more often linked to ocular adnexal trauma, underscoring the importance of fracture pattern in predicting ocular morbidity. The high rate of early visual impairment further highlights the need for systematic ophthalmic assessment in all polytrauma patients with facial injury. These results support the integration of early ophthalmologic evaluation into trauma pathways to prevent missed injuries and optimize visual outcomes.

ETHICAL DECLARATIONS

Ethical approval: The study protocol was approved by the Institutional Review Board of Tehran University of Medical Sciences (IR.TUMS.SINAHOSPITAL.REC.1401.118). All procedures conformed to the tenets of the Declaration of Helsinki. At hospital admission, all patients provided written informed consent for clinical evaluation and treatment as part of routine care. In accordance with institutional policy at educational hospitals, patients also signed a general consent permitting the use of de-identified medical information for educational and research publication purposes.

Conflict of interests: None.

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