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Ocular injuries among hospitalised burn victims: A one year census at a national tertiary centre

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ABSTRACT

Ocular injuries are potentially sight-threatening complications of burns that are frequently overlooked in clinical practice. To describe the epidemiology, mechanisms, clinical spectrum, and outcomes of ocular burns in hospitalized patients. We performed a one-year retrospective census of all burn in-patients who received ophthalmology consultation at Motahari Hospital, Tehran (April 2021–March 2022). Demographics, burn characteristics, ocular findings, management, and outcomes were extracted from charts and analyzed using descriptive statistics and chi-square or Mann-Whitney U tests. Among 1,914 admissions, 74 (3.9%) received ophthalmologic consultation, and 69 (3.6%) were diagnosed with ocular injuries. Patients were predominantly male (78%) with a median age of 29 years (Interquartile Range (IQR) 6–47 years). Flame exposure was the commonest mechanism (49%), followed by chemical (19%) and scald (19%) burns. Eyelid involvement occurred in 99% of cases, conjunctiva 61%, cornea 39% and limbus 7%. Corneal injury was significantly associated with chemical burns ($p = 0.01$). Ninety-two percent received medical therapy alone; 14% underwent surgery (cutaneous graft 9%, ocular procedure 5%). The median length of stay was 9 days (IQR, 5–16). Permanent ocular sequelae developed in five patients (7%), and mortality was 20%. In this large tertiary cohort, ocular burns affected 1 in 25 admitted burn patients, chiefly young men injured at home. The eyelids shield deeper structures, yet chemical exposure remains a significant threat to the cornea and limbus. Early ophthalmic assessment and standardized lubrication protocols could reduce the need for reconstructive surgery. Public-health measures aimed at domestic fire safety and chemical handling are warranted. This study highlights the importance of implementing routine ocular screening protocols in burn units, particularly for patients with high-risk exposures.

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1. Introduction

Facial burns are among the most devastating medical and psychological traumas, resulting in facial disfigurement, functional and cosmetic disabilities, and social isolation. These injuries can involve the ocular and periorbital area up to 7.5-36% [1]. Thermal, chemical, or low- or high-voltage electrical burn, or radiation, can cause ocular injuries with different features and structural involvement, all of which are considered medical emergencies. Thermal burns are primarily caused by flames, scalds, and fireworks, which tend to affect the periorbital area more than the globe due to the blink reflex. However, the extent of damage depends on the duration and extent of exposure as well as the nature of the causative agent [2]. Chemical burns are usually associated with assaults or industrial accidents, and are more frequent in young males aged 20-40. Alkaline agents are more destructive because their hydrophilic and lipophilic characteristics lead to deeper tissue penetration [3]. Ocular changes from electrical burns result from vascular damage leading to progressive tissue necrosis. These changes can cause conjunctival hyperemia, corneal opacities, uveitis, cataracts, retinal edema, papilledema, chorioretinal necrosis/atrophy, retinal detachment, and optic atrophy [4,5]. Immediate ocular evaluation is crucial to assess the extent of injury before tissue edema occurs. This evaluation includes a basic ophthalmic examination, checking fornices for any remaining agent, irrigating with isotonic serums in chemical burns, providing efficient ocular surface lubrication, administering topical antibiotics for infection, topical steroids for edema, and topical anesthetics for pain [6]. However, these injuries can be overlooked due to early life-saving interventions. Immediate and appropriate treatment can decrease the extent of tissue damage, improve prognosis, speed up vision recovery, and reduce future complications [7]. Ocular sequelae can result from primary injuries such as eyelid burns, conjunctival ecchymosis, chemosis, erosion of corneal epithelium, or be secondary to ectropion, lid retraction, exposure, drying, infection, corneal scarring, and opacification [8,9]. Previous studies have primarily focused on a single mechanism of ocular injuries resulting from burns. This study aimed to describe the epidemiology, causes, and clinical characteristics of ocular injuries from different burn agents. By examining their management and outcomes, we aim to inform more effective prevention and treatment strategies.

2. Materials and Methods

In this retrospective cross-sectional study, all patients admitted with a diagnosis of acute burn who underwent an ophthalmological consultation at Motahari Hospital from April 2021 to March 2022 were included. Patients without an ophthalmological consultation, those without acute burns, and outpatients were excluded from the study. Demographic and medical information, including age, sex, nationality, occupation, burn agent, accident site, cause of the accident, types of ocular injuries, length of hospital stay, interventions (such as drug therapy, surgery, or graft), and mortality rate, were obtained from patients' files. Types of ocular injuries were classified based on anatomical components. An ocular injury was recorded when slit-lamp or indirect ophthalmoscopy revealed an epithelial defect, stromal haze, limbal ischemia, uveal inflammation, or posterior-segment pathology, graded according to Dua's classification. The accident site was divided into three groups: outdoor, indoor, and workplace. The cause of the accident was categorized as accidental, assault, or suicidal injuries. Burn agents were classified according to the mechanism of injury, including flame, scalds, acid, alkali, low voltage, high voltage, and fireworks. Data were analyzed in SPSS v22 using descriptive statistics, followed by x^2 tests for categorical comparisons and Mann-Whitney U tests for non-parametric continuous variables ($\alpha = 0.05$). Quantitative data were reported as mean ±standard deviation, while qualitative data were reported as counts and proportions. Variables with >10 % missingness (Total body surface area (TBSA), time-to-consult) were flagged and analyzed with pair-wise deletion; completeness for core variables exceeded 94 %.

3. Results

Between April 2021 and March 2022, a total of 1914 burn patients were admitted to Motahari Hospital. Out of the 74 patients who underwent ophthalmological consultation, 69 (3.6%) were diagnosed with ocular injuries. 78.3% of the patients were male (n=54), and 21.7% (n=15) were female. The patients' age ranged from 1 to 72 years, with the most common age group being 18–40 years (49.3%) (Table 1). The average length of stay was 13.2 days (SD= ± 11.7) (Table 2). The TBSA was less than 10% in 28 patients (40.6%), between 10% and 29% in 22 patients (31.9%), and 30% or more in 19 patients (27.5%). The most common cause of ocular injury was accidental (81.2%) (Table 1). The most common mechanism of injury was flame burns (49.3%). Chemical and scald burns were equally represented at 18.8%, suggesting a non-negligible role for non-thermal agents in ocular involvement (Table 3). Almost half of the injuries occurred in residential areas (52.7%). Medical treatment was received by 91.9% (n = 67) of patients; however, eyelid skin grafts and specialized ophthalmological surgery were only performed on a minority of patients (8.1% and 5.4%, respectively) (Table 2). In our patients, 98.6% (n = 68) suffered from lid injuries. The second most common site was the conjunctiva, which was present in 60.9% of them. Retinal injury was the least common site of damage, representing only 1.4% (n=1) of injuries. Nearly 3% of patients were blind at the time of discharge. The mortality rate in patients with ocular involvement was around 20% (Table 3). Eyelid involvement was observed in 72.4% of flame burns,

50% of scald burns, 35.6% of electrical burns, and 32.7% of chemical burns. Corneal involvement was seen in 26% of chemical burns, 23.5% of electrical burns, 15.2% of scald burns, and 5.5% of flame burns. According to 66.6% of suicides and 47% of accidents, eyelid injuries resulted. Corneal injuries were detected in 23% of assaults and 17.9% of accidental burns (Table 4).

Table 1. Demographic and Clinical Characteristics of Patients with Ocular Burns (n = 69)

Variable	Frequency (%)
Sex	
Male	54 (78.3%)
Female	15 (21.7%)
Age group (years)	
0–5	10 (14.5%)
6–17	12 (17.4%)
18–40	34 (49.3%)
>40	13 (18.8%)
Burn mechanism	
Flame	34 (49.3%)
Chemical	13 (18.8%)
Scald	13 (18.8%)
Electrical	6 (8.7%)
Others (e.g. radiation)	3 (4.3%)
Accident location	
Home	33 (47.8%)
Workplace	21 (30.4%)
Outdoors/public space	10 (14.5%)
Unknown	5 (7.2%)
TBSA (%)	
<10%	28 (40.6%)
10–29%	22 (31.9%)
≥30%	19 (27.5%)

Table 2. Ocular Structures Involved and Treatment Types (n = 69)

Variable	Frequency (%)
Ocular structure involved	
Eyelids	68 (98.6%)
Conjunctiva	42 (60.9%)
Cornea	27 (39.1%)
Limbus	5 (7.2%)
Posterior segment (e.g. retina)	2 (2.9%)
Treatment modality	
Medical therapy only	63 (91.3%)
Eyelid skin graft	6 (8.7%)
Ocular surgery* (e.g. amniotic membrane graft, tarsorrhaphy)	3 (4.3%)

*Note: Ocular surgeries included procedures such as amniotic membrane grafts and tarsorrhaphy. Percentages may not total 100% as some patients had multiple injuries or received more than one treatment.

Table 3. Clinical Outcomes in Patients with Ocular Burns (n = 69)

Outcome	Frequency (%)
Full visual recovery	60 (87.0%)
Permanent ocular sequelae*	5 (7.2%)
Blindness in at least one eye	2 (2.9%)
Required Intensive Care Unit (ICU) admission	14 (20.3%)
In-hospital mortality	14 (20.3%)

*Permanent ocular sequelae included conditions such as chronic dry eye, symblepharon, corneal scarring, and eyelid malpositions. Percentages may not sum to 100% due to rounding or overlapping conditions.

Table 4. Ocular Involvement by Burn Mechanism (n = 69)

Burn Mechanism	Eyelid (%)	Conjunctiva (%)	Cornea (%)	Sclera (%)	Limbus (%)	Posterior Segment (%)
Flame (n=34)	72.4	16.8	5.5	5.5	0	0
Chemical (n=13)	32.7	28.4	26.0	4.3	8.6	0
Scald (n=13)	50.0	31.8	15.2	3.0	0	0
Electrical (n=6)	35.6	23.5	23.5	5.8	5.8	5.8
Fireworks/Others (n=3)	50.0	50.0	0	0	0	0

*Patients may have multiple ocular structures involved. Percentages represent frequency of involvement within each burn mechanism group and may exceed 100%.

4. Discussion

Orbital and periorbital injuries related to burns are common in facial burn cases, occurring in up to 36% of instances [1]. Previous research indicates that the eyelids and cornea are the ocular structures most often affected; these findings are consistent with our data [1,10]. This study aims to explore various aspects of burn-related ophthalmic injuries, offering more insight into these ocular emergencies. Out of the 1914 patients included in this study, 3.8% (n=74) required an ophthalmological consultation, with 3.6% (n=69) being diagnosed with ocular injuries. Ocular involvement was identified in 15.3% of chemical burns and 4.8% of thermal burns. Given that inclusion was limited to referring patients, minor ocular injuries were likely underrepresented, emphasizing a potential gap in routine ocular screening among burn patients. A 10-year retrospective study conducted by Cabalag et al revealed 13.3% of patients had associated periorbital and orbital injuries [1]. The lower prevalence in our study may be attributed to a shorter study period and the exclusion of outpatient cases. Previous research has indicated a higher prevalence of chemical burns in ocular injuries [11,12]. Among the 69 patients, 54 (78.3%) were male and 15 (21.7%) were female, with a mean age of 33.51 years. Being male and younger can increase the risk of facial burns [13]. Male individuals in industrial environments, or those who engage in risk-taking behaviors, appear to be more susceptible to burn-related ocular injuries. The predominance of young individuals highlights the importance of implementing safety policies for this at-risk population and providing public health education [14]. Similar to previous studies most incidents of exposure were a result of domestic accidents, which can be prevented by adhering to basic residential safety standards such as safe storing of flammable materials safely, ensuring standard household wiring, installing smoke detectors, and supervising children, elderly; and individuals and those who are physically or mentally-impaired when near hot water [1,15]. The most common mechanism of injury observed was flame burns, affecting 49.3% of patients, followed by scald burns and chemical burns. These findings can be attributed to the higher prevalence of thermal agents causing burns [16,17]. The average percentage of body burn was 21.9%, with a group of 10-15% being the most common. The mortality rate in patients with ocular injuries was 20.3% (See Table 3 for detailed clinical outcomes). Despite a high rate of full visual recovery (87%), the notable incidence of permanent sequelae (7.2%) and blindness (2.9%) confirms the sight-threatening potential of these injuries. One possible explanation for these findings is that ocular injuries are often part of head and neck burns, which can lead to critical situations such as airway edema, speech or swallowing dysfunction, sensory deficits, and scarring/disfigurement [18]. Eyelid burns were a common occurrence in cases involving the eyes, presenting in almost all cases (98.6%), followed by conjunctival involvement (60.9%) and corneal involvement (39.1%). The predominance of eyelid injury underscores the need for immediate lubrication protocols and twice-daily eyelid position checks to prevent exposure keratopathy. The high chemical-burn correlation with corneal damage supports stocking pre-mixed ocular irrigation kits on burn wards. This finding is consistent with previous studies, which have reported that eyelid and corneal burns are the most frequent sites of injury [19]. Cabalag et al reported 80% of eyelid burns and 70% of corneal injuries in their study [1]. Another survey of 210 severely burned patients found that 60% had burn-related damage in the periocular region, with only 14% diagnosed with primary ocular injuries [20]. The higher rate of injury in the periorbital region compared to the orbital structures may be attributed to protective mechanisms, such as the blink reflex, Bell phenomenon, and protective movements of the head and arms, which prevent severe damage to the orbital structures [21]. In this study, periorbital involvement was significantly higher in scald burns (72.2%) and flame burns (50%) compared to chemical (32.6%) or electrical (35.2%) burns. Similar to our study, O'Connor et al. reported the etiology of periorbital burns as follows: flame, 71.8%; hot water scald, 17.4%; electrical, 4.8%; hot oil scald, 3.8%; and chemical burns, 1.9% [22]. On the other hand, corneal injuries were most common in chemical burns, followed by scald and flame burns. Limbal ischemia was only detected in patients with chemical burns (8.6%) and electrical burns (5.8%). Statistical analysis confirmed a significant association between chemical burns and corneal involvement ($p = 0.01$), supporting previous findings on the aggressive nature of alkali injuries. Retinal and macular involvement was only detected in one case of electrical burn. Our study highlights the fact that the globe can tolerate thermal injury as a result of eyelids. Providing a protective mechanism is ineffective in more severe thermal burns or chemical burns due to the destruction of the eyelids or deep penetration of chemical agents, especially alkaline substances that can lyse cellular membranes and penetrate the cornea and anterior chamber [23,24]. Eyelid injury was most common in suicides and accidents, respectively. Corneal and conjunctival involvement was slightly higher in assaults. Limbal ischemia was three times higher in assaults. Previous studies have shown that flammable liquids or gases are used in 80% of suicide cases, resulting in severe burns and a higher potential for death and disability [25]. Conversely, assault victims usually suffer from acid throwing on their faces in order to cause facial deformity or visual impairment [26], which can explain the higher prevalence of corneal and limbal involvement in assaults. Patients requiring ophthalmological surgery or eyelid skin graft accounted for 4 (5.8%) and 6 (8.7%) of the 69 patients, respectively. However, medications such as lubrication or antibiotic ointment were also used for almost all

patients (98.6%) due to reduced tear production, blink reflex, and eyelid movement. Although only a minority of patients required surgery, previous studies emphasize that interventions for ocular burns typically involve multiple and challenging procedures [27,28]. This low surgical rate may reflect the effectiveness of early interventions, such as lubrication and topical medications, supporting the importance of timely ophthalmologic input. Spencer et al stated that the rate of ocular surgery was 18.4% compared to 30% when no prophylaxis was used [29]. These results underscore the importance of early detection and serial examination in minimizing ocular complications. Because data were abstracted from routine charts, misclassification and omission are possible, despite double-entry verification; this may have biased the associations toward the null. Residual confounding by total burn surface area, inhalation injury, or delay to referral cannot be excluded.

Like most studies, this study has limitations, as it is a single-center series from Iran's national burn unit. Patterns may differ in regional hospitals; therefore, a multi-center collaboration is needed to confirm external validity. Also, it focused on admitted burn patients with ocular injuries, excluding outpatients and referral cases. Therefore, it was not possible to assess cause-and-effect relationships between variables. Including both inpatients and outpatients over a more extended period is recommended for future studies.

Burn-related ocular injuries are true emergencies that require immediate evaluation, close observation, and appropriate management. These injuries vary based on the mechanism or cause of the burn and mostly occur in young individuals, particularly in the setting of residential accidents. The importance of eyesight in quality of life makes ocular injury a significant challenge for medical staff and a substantial burden on the healthcare system. Understanding the etiology and prevalence of these injuries is crucial for developing effective prevention strategies. Implementing standardized ocular screening protocols for all admitted burn patients may reduce the incidence of missed injuries and improve long-term outcomes. Early ocular irrigation, immediate evaluation, and ophthalmological examination are as crucial as further intensive treatments and surgical interventions.

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Authors' contributions

SHS: contributed to the study design. SAS: collection of the data. KAs: performed the data analysis. AHS: interpreted the data. KA: contributed to the manuscript writing. All authors read and approved the final version of the manuscript.

Conflict of interest

No potential conflict of interest was reported by the authors.

Ethical declarations

Throughout the project, we adhered to the basic principles of the Helsinki Declaration and the Ethics Committee of Iran University of Medical Sciences (Ethics code NO. IR.IUMS.FMD.REC 96.9211216213).

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