ORIGINAL ARTICLE

Epidemiological Features of Ocular Chemical Burns in Iran

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ABSTRACT

Purpose: To evaluate the epidemiological features of ocular chemical burns in Iran.
Methods: 96 patients with ocular chemical injuries were retrospectively studied. Patients underwent complete ophthalmological examination. Gender, laterality of involved eye, type of chemical substances, grading of injury, location where injury occurred, history of irrigation prior to admittance, and surgical procedures were evaluated.
Results: 117eyes of 96 patients were enrolled in this study. 79% of the patients were injured while working, whereas 13.54% were hurt at home. Also, seven patients were injured during an assault. 37 individuals (38.5%) did not receive any irrigation immediately after the injury. Among them, 71.42% of assault cases, 39.47% of injuries during work, and 15.38% of burns at home did not irrigate their eyes prior to admission. Amniotic membrane grafting, tenonplasty, and tarsorrhaphy were the most performed surgeries for the patients.
Conclusion: Patients who were injured at workplace and during an assault, irrigate their eyes less than patients who were injured at home. Therefore, educating of general population, making instructions on chemical agents, workplaces and factories and also equipping high risk places to the specific eye-washing devices are vital parts of regulation policies.
Keywords: Epidemiological Features, Ocular Chemical Burns.

INTRODUCTION

Ocular chemical burn is one of the most common and serious ophthalmic emergencies with rising incidence in developing countries which may lead to irreversible damages of anterior segment and catastrophic complications like blindness [1]. Chemical and thermal burns are responsible for about 15% of eye events [2]. Although the majority of chemical injuries are mild and without significant adverse outcomes [2], sometimes severe complications such as glaucoma, corneal opacity or perforation, symblepharon, ectropion or entropion, cataract, and retinal detachment may affect normal function of the injured eye [3].

Nature of material, duration of contact with eyes, volume and penetration of the solution are determining factors of damage severity [2]. Potential hazard of alkalis are significantly more than acids; Alkalis can lead to irreversible damages in 5-15min through saponification of cell membranes and rapid extension to the anterior chamber. Conversely, acids coagulate superficial tissues and fail to penetrate deeply into ocular structures. Exception of this rule is Hydrofluoridric acid which has a behavior like alkalis [4-9].

Management of ocular chemical injuries is a challenging issue and divides to immediate phase, acute phase and chronic phase; initial treatment includes normalization of ocular surface PH through copious irrigation with clean water or isotonic saline solution even to 20L volume and removing foreign body particles. The goal of early management focuses on preserving globe integrity, recovery of epithelial surface and suppressing inflammation; while long-term management aims to treat tear deficiency, limbal stem cell deficiency, and associated complications such as exposure keratopathy, cataract, and glaucoma [8, 10-13].

Ocular chemical burns may have high impacts on quality of lives and health system economic. Thus, epidemiologic studies can play an important role in regulation of public health policies and future actions. Epidemiologic information on ocular chemical burns is limited in the Middle-East where the safety standards are low. This study shows the nature of ocular chemical burns, severity of damages, and also commonly used surgical procedures for the patients in the major referral ophthalmic center of Iran.

MATERIAL AND METHODS

The medical records of 96 hospitalized patients with ocular chemical injuries who were attended to the emergency ward of Farabi Eye Hospital from January 2014 to December 2019 were reviewed retrospectively. This research was undertaken in accordance with the Declaration of Helsinki and confirmed by Farabi Eye Hospital Institutional Review Board. All patients underwent complete ophthalmological examination including visual acuity assessment, applanation tonometry, slit lamp examination and indirect ophthalmoscopy with 90D lens. All patients were asked to bring in the causative chemical agent after starting the treatment if they didn't know the substance, unless it was not available.

Statistical analysis was performed using a statistical software package (SPSS for Windows, version 23.0; SPSS, Inc., Chicago, IL). A descriptive study was done on quantitative variables using mean and standard deviation, while qualitative variables (gender, laterality of involved eye, type of chemical substances, grading of injury (according to Dua's classification system [14, 15]), location where injury occurred, history of irrigation at the place of accident, and used surgical procedures) were described with frequency and percentages.

RESULTS

One hundred and seventeen eyes of 96 patients (age: 36.05 years [2-79], male/female: 81 (84.4%): 15 (15.6%)) with ocular chemical injury were enrolled in this study. Bilateral chemical injuries were seen in 21 patients. Seventy-nine percent of the patients were injured while working, whereas 13.5% were hurt in the home and 7 patients were injured in an assault. Table 1 shows demographic data and grade of injury at presentation.

Sulfuric acid was the most prevalent caustic agent which involved 34 (35.4%) of the patients as it is commonly used in industry. Table 2 shows prevalence of caustic agents among patients who were injured during work or at home. The caustic agent in patients who were injured during an assault was unknown.

Examples of some of common causative agents are listed in table 3 [10].

Fifty-nine (61.5%) patients had their eyes irrigated immediately after the injury and prior to admittance to the hospital (pre-treatment), whereas 37 (38.5%) did not receive any irrigation. Table 4 shows number of patients who had done irrigation prior to admittance to the hospital in subgroups based on place of injury.

Initial visual acuity ranged from 9/10 to no light perception. Surgical intervention was performed for 100 eyesin the form ofamniotic membrane grafting (n = 61), tenonplasty (n = 37), tarsorrhaphy (n = 32), conjunctival flap (n=11), penetrating keratoplasty (n = 4), and conjunctival limbal autograft for limbal stem cell deficiency (n = 4). The average number of surgeries was 2.9 (range 1-5). The best-corrected visual acuity in the final follow-up is shown in table 5.

DISCUSSION

Ocular chemical burn represents a significant percentage of emergency-treated ocular traumas as counting for 36000 emergency department visits and $26.6 million charges every year in America. Absence of the patient and her/his family members at work resulting in less productivity, hospitalization and medical care costs are the most important reasons of this economic burden [16].

Higher rate of ocular burns in men has been showed in our study as well as previous reports from other world's regions [17-21]. Like the majority of available studies, in this study work related injuries were more common [19, 21-23]. However, in study of Kersjes et al. about 85% of injuries occurred at home. Monocular involvement is more common in the majority of studies [24]. It should be mentioned our binocular involvement (21.9%) was lower than36.5% and 42.1% by Aleksandra Radosavljević et al. and Saini et al., respectively [25, 26].

The other considerable point is chemical burns in children; Number of ≤16 years patients in our study was similar to report by Markus Tschopp et al. (8 patients). However severity of damage in this age distribution was significantly more in our study (one patient with stage VI, three patients with stage V, three patients with stage III, and one patient with stage II of injury in our study in comparison 8 patients with stage I in their study) [27].

In contrast to our expectations, number of male cases in assault category was more than females (4 males and 3 females). We thought due to religious atmosphere and cultural issues of Iran, victims of this type of chemical injuries are predominantly women. The other considerable point of chemical injuries caused through assaults is using more potent agents resulting in higher grades of damage. In our series three of patients have been complicated with grade VI of burns and none of the seven patients experienced vision better hand motions (HM).

Alkalis are accounted as the most frequent causes of ocular chemical burns. Pathophysiology of their damages is saponification of cell membranes which makes more severe damages than acids [16, 28, 29]. Strong acids such as sulfuric acid which is found in car batteries and swimming pool cleaners denature corneal proteins resulting in inability to more extension except Hydrofluoridric acid which is found in antirust solutions and acts like alkalis agents despite its weak potency [6]. It's noticeable in contrast to the majority of previous reports prevalence of chemical burns caused by acidic agents was more than alkalis in our study (88 patients (52 cases (59%) in acid group and 36 cases (41%) in alkali group) [30-32]. As overall 75.2% of our patients have been experienced severe damages of ocular burns (grade III - VI) which may be associated to performing this study in a tertiary referral center and inclusion of only hospitalized patients.

Jiaxu Hong et al. have been reported chemical injuries usually occur in persons who do not use eye protection during work despite their awareness of its importance [33]. Similarly, Kuckelkorn et al. reported up to 100% of patients were not using protective equipment at the time of accident [34]. This finding makes reinforcement and legislature necessary to improve work safety.

The most important prognostic factor of visual outcome is degree of damage severity [28]. Thus, Importance of classification of injuries is in determining prognosis and appropriate required treatment approach. Results of one study revealed that Dua's classification has superior predictive value than Roper-Hall system due to dividing Grade IV of injuries in 3 separate sub classifications. On the other hand it has been shown that amniotic membrane transplant has superior results when is performed in grade IV of burns rather than grades V and VI [6]. Our study is one of the limited reports in which Dua's classification has been used to evaluating the patients.

Interestingly contact time of chemical agents with eyes is determining factor of damage severity [35]. So the most important primary step in treatment of ocular chemical injury is to immediately irrigation of the ocular surface in order to remove the caustic agent [36-38]. Immediate and thorough irrigation should be performed at the site of injury and prior to any ophthalmologic examination, as swift action for removal of offending material could be vital [39, 40]. Although, solutions such as ringer lactate and balanced saline solution have been suggested for emergency neutralization of ocular chemical injuries, tap water still remains the main aqueous solution due to its availability. Remarkable percentage (38.5%) of patients did not mentioned irrigation before arrival to our hospital. This issue represents lack of enough knowledge about chemical injuries among the public.

Unfortunately, surgical management of more severe stages of chemical burns is inevitable as 100 eyes (85%) of injured eyes in our study experienced surgical interventions. The majority of these surgical techniques are highly cost, not available in the most of the centers, and occasional without acceptable outcomes. These aspects of chemical burn management make the role of preventive actions more prominent.

In this study we showed that patients who were injured at workplace and during an assault, irrigate their eyes less that patients who are injured in home. Therefore, using formal education, making instructions on chemical agents, workplaces and factories and also equipping high risk places to specific eye-washing devices are vital parts of regulation policies. Also, we recommend allocating an open access hotline telephone number on toxicological information for public and healthcare providers may be useful in countries with high prevalence of chemical burns.

Limitations of this study is retrospective nature of the study potentially result in incomplete patient selection and collection of data.

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Ethical approval: All procedures performed in the study including human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The approval number given by the ethical board of Farabi Eye Hospital Institutional Review Board: 87-45667

Consent: Written consent was obtained from the patients.

Competing interests: The authors declare that they have no competing interests.

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Table 1. Demographic data, location of accident, and grading of injuries.

Sex (male: female) [%]		(81: 15) [84.4: 15.6]
Age (mean ± SD) [range]		(36.05 ± 12.43) [2-79]
Laterality (Bilateral: Unilateral)		21(21.9: 78.1)75
Place of Injury	Work (%)	76 (79.16)
	Home (%)	13 (13.54)
	Assault (%)	7 (7.29)
Grade of Injury (eyes)	Grade 1 (%)	4 (3.4)
	Grade 2 (%)	25 (21.4)
	Grade 3 (%)	23 (19.7)
	Grade 4 (%)	15 (12.8)
	Grade 5 (%)	10 (8.5)
	Grade 6 (%)	40 (34.2)

Table 2. prevalence of caustic agents.

Caustic agent					
Work	Sulfuric acid	32 (42.1%)	**Home**	Sulfuric acid	2 (15.38%)
	Acetic acid	8 (10.52%)		Acetic acid	-
	Hydrochloric acid	7 (9.21%)		Hydrochloric acid	3 (23.07%)
	sodium hypochlorite	6 (7.89%)		sodium hypochlorite	7 (53.84%)
	Ammonia	6 (7.89%)		Ammonia	-
	Potassium hydroxide	7 (9.21%)		Potassium hydroxide	1 (7.69%)
	Magnesium hydroxide	9 (11.84%)		Magnesium hydroxide	-
	Unknown	1 (1.31%)		Unknown	-

Table 3. Examples of some of common causative agents.

Chemical	**Example**
Sulfuric acid	Battery acid, industrial cleaner
Acetic acid	Vinegar, glacial acetic acid
Hydrochloric acid	Chemical laboratories
Ammonia	Fertilizers, refrigerants
Potassium hydroxide	Caustic potash
Magnesium hydroxide	Sparklers, incendiary devices

Table 4. Patients who had done irrigation prior to admittance to hospital.

Irrigation prior admittance							
All patients (n=96)		Work (n=76)		Home (n=13)		Assault (n=7)	
Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)
59 (61.5)	37 (38.5)	46 (60.52)	30 (39.47)	11 (84.61)	2 (15.38)	2 (28.57)	5 (71.42)

Table 5. Best-corrected visual acuity at final follow-up after ocular chemical injuries.

Final Visual Acuity	**N (%)**
≥3/10	11 (11.4)
1/10 – 3/10	21 (21.9)
<1/10	60 (62.5)
Unknown (not cooperative)	4 (4.2)