80370_Auto_Edited.docx

WORD COUNT 2358
TIME SUBMITTED 10-JAN-2023 03:49PM
PAPER ID 95372384

Name of Journal: *World Journal of Clinical Cases*

Manuscript NO: 80370

Manuscript Type: MINIREVIEWS

Epidemiology and etiology of chemical ocular injury: A brief review

Akgun Z *et al.* Epidemiology and etiology of chemical ocular injury

Zeynep Akgun, Ozlem Barut Selver

Abstract

Chemical ocular injury is one of the common ophthalmologic emergencies that can cause vision loss and serious complications. Despite all protective measures, it continues to be a serious public health problem, especially in young male patients. Although it is known that injuries occur most frequently in the workplace and in young male patients, there is a variable frequency and distribution in different regions around the world. In addition, with the coronavirus disease 2019 pandemic, there are changing trends in ocular chemical injuries. This review aims to specify an update on the epidemiological and etiological features of ocular chemical injuries.

Key Words: Chemical ocular injury; Alkaline; Acid COVID-19; Epidemiology; Etiology

Akgun Z, Selver OB. Epidemiology and etiology of chemical ocular injury: A brief review. *World J Clin Cases* 2022; In press

Core Tip: Epidemiological and demographic characteristics are important to prevent ocular chemical injuries, one of the most important ocular emergencies.

INTRODUCTION

Ocular surface chemical injuries are ophthalmological emergencies that can cause prompt destruction, serious anterior segment complications, and permanent visual loss[1]. Chemical eye injuries have accounted for a significant proportion of ocular traumas over the years. Studies in the 80s-90s report that chemical injuries accounted for 7.7%-18.0% of all ocular injuries. In 2018, Sharma *et al*[2] reported that chemical injuries are responsible for approximately 11.5%-22.1% of ocular injuries[3]. Effective and rapid intervention, clinical evaluation of the injury severity, and prompt treatment are essential. Injury grade depends on the causative agent type, pH, and exposure time. Appropriate and sufficient management of the chronic process of the disease results in better visual outcomes and lower complication rates. The visual prognosis of a severe ocular chemical injury is generally poor[4]. However, current developments in treatment strategies are encouraging for both visual and clinical outcomes. Evaluation of the epidemiological and etiological factors of ocular chemical injuries benefits to prevent injuries. Ocular chemical injuries can be classified in accordance with various factors such as agent type, type of injury, gender, and age. It is known that most injuries occur at work in the young male population. However, it varies according to the socioeconomic and educational status of the countries, and the rate of use of protective equipment[5]. Ocular chemical injuries may occur due to assault and assault injuries are frequently associated with more serious injuries[6,7]. Consequently, ocular chemical injuries and their sequelae create a serious social, economic, and psychological burden. This brief review aims to present a current approach to the epidemiology, etiology, and predisposition of ocular chemical injuries.

Severity and prevalence

Ocular chemical injuries account for 10.7%–34.7% of all chemical burn injuries. Also, 0.1%–15.5% of all ocular traumas among hospitalized adults are secondary to ocular chemical injury, and this rate has increased over the years[8,9]. For example, a study from Serbia reported that ocular surface chemical injuries accounted for 2.7% of hospitalized ocular injuries in 1999 and 15.5% in 2008[10]. In 2021, in a meta-analysis of 88 studies,

Ahmed *et al*[5] reported that ocular chemical injuries have an incidence ranging from 5.1 to 50 per 100000 population per year in different countries. The incidence of chemical injury was reported as 5.11/100000/year in the United States in 2015 and 5.6/100000/year in the United Kingdom in 2019. Likewise, in 2015, it was reported as 50/100000/year for the working population in Switzerland. In economically underdeveloped countries, the rate of chemical ocular injuries was lower (2.2%-8%) among emergency ocular traumas, and it was 11-13% in developing countries such as Turkey[11,12]. Considering the seasonal distribution of chemical injuries, it has been reported that they occur more frequently in Serbia and the United States in summer and in Turkey in winter[13].

The severity of injury varies considerably between studies, with the frequency of mild injuries ranging from 57% to 70%. The prevalence of severe injury in the United Kingdom was reported as 0.02/100000/year in 2009 and 0.29/100000/year in 2019. Similarly, it was reported as 1.58/100000/year in China in 2010[14,15]. The distribution of chemical injury severity may vary in accordance with socioeconomic conditions. In the literature, in developed countries, low-grade chemical injuries (grades 1-3) account for approximately 83%-90% of all chemical injuries. In contrast, severe injuries occur more frequently in developing and underdeveloped countries[15,16]. Bizrah *et al*[17] reported that of all ocular chemical injuries, 83% were low-grade injuries and 17% were serious injuries in the United Kingdom. In contrast, a similar study from India reported that 51% of eyes had low-grade injuries, but 35.9% had serious injuries[18]. While only alkaline agents were evaluated, Merle *et al*[19] reported that 50% of injuries were grade I, 31% were grade II, and 19% were grades III-IV according to the Roper-hall classification, in Martinique. Similarly, Moon *et al*[20] found that 75% of all alkali ocular surface injuries were grade I injuries in Australia. Nevertheless, the hospitalization rate was not related to economic development. Assault-related ocular chemical injuries are not unique to developing countries with similar frequency worldwide. Moreover, there has been a global increasing trend recently[21]. Assault-related cases were noted to result

in more serious injuries globally. Studies from India and Martinique reported that 50% and 32.7% of assault-related eye injuries are high-grade injuries, respectively[22].

Causative agents

Alkaline injuries are more common than acidic injuries due to their extensive industrial and domestic use[23]. Alkaline agents pose a therapeutic challenge in the management of chemical injuries. Alkaline agents have a higher penetration rate than acids[24]. The most important factor determining the potency of an alkaline agent is pH, and severe corneal damage occurs if the pH is 11.5 or more[25]. Alkaline agents cause saponification of cell membranes due to their lipophilic nature. The hydroxyl ions in alkali cause saponification of the cell membrane, leading to cell membrane lysis. They can promptly penetrate the anterior segment of the eye, such as the iris, ciliary body, trabecular meshwork, and crystalline lens. The inflammatory response progresses quickly due to the release of proteolytic enzymes from the injured tissue. In addition, associated vascular damage leads to ischemia. In contrast, acids fix and coagulate the superficial tissues which prevent deep penetration of the agent[26]. Alkaline injuries account for 19–73% of all cases of ocular chemical injury. The rate of ocular chemical injuries caused by alkaline agents was reported to be 66.7%-67.9%[27,28]. Acids account for approximately 5%–47.6% of cases, with sulfuric, hydrochloric, and nitric acids being common[13,29]. High-grade injuries mostly occur with alkaline agents. Kılıç Müftüoğlu *et al*[30] reported that 80.9% of chemical injuries were due to alkaline agents, and 48.1% of patients with alkali damage were severe. Sodium hydroxide and lime were the most common causative agents, causing 26% and 65% of alkaline ocular surface injuries, respectively[31]. Among alkaline substances, ammonia has the highest destructive potential, and lime is relatively less toxic[32]. The most common cause of ocular surface injuries by acidic agents is sulfuric acid, which rarely causes high-grade ocular injuries. Injuries with these agents have often occurred in the industry (construction, manufacturing, chemical, petroleum, *etc.*) and at home (household cleaning and personal care products)[33]. However, distinct from other acids, hydrofluoric acid has a

strong liquifying effect on cell membranes and has an analogous effect to alkaline agents[34]. In spite of being a weak acid, hydrofluoric acid easily penetrates the corneal epithelium. In deeper tissues, hydrofluoric acid dissolves, and the free fluoride ions released cause irreversible damage[35].

The workplace was a common site of ocular surface injury, where 43%–86% of all cases in adults occurred. Ocular chemical injuries were responsible for 6%-45% of occupational ocular injuries and 2.8% of occupational burns. Characteristically, young males working in the industry are the most common patient group[36]. In the literature, it is reported that almost two-thirds of ocular injuries occur in the workplace among people of working age and male gender (ratio 3-8:1). In a study conducted in Germany, a total of 131 severe ocular injuries were recorded, with 84% being chemical injuries and 72% being work-related[16]. In a study from Turkey, Akgun *et al*[37] reported that the most common cause of injury (45.1%) was occupational accidents and it was more common in men (male/female: 86/18) in the last 10 years. There is a variability of protective equipment used in the workplace, depending on the development status of the country. From Nigeria, Adepoju *et al*[38] reported that protective equipment was not used in any of the work-related chemical ocular injuries. Moreover, even in developed countries, the use of protective equipment may still be inadequate. Domestic and hobby injuries accounted for 7%-33% of ocular chemical injuries. In the United States, domestic injuries were more common in children (13.8%) and patients over 65 (16.4%) compared to the 18-64 age group (8.72%)[39].

Age and gender

While ocular chemical injuries can occur in all age groups, it is known that the group most at risk is young adult men. It has been reported in studies that 54.4%-97.5% of the cases were men. However, the rate of injuries caused by domestic products is higher in women. It is known that patients between the ages of 15-35 account for more than half of all cases[18,40,41]. However, several studies in the United States, Serbia, and China noted that 41-50 years old had the highest injury frequency of all age groups[13,42].

Furthermore, children are at risk for ocular chemical injuries. The rate of ocular trauma secondary to chemical injury in children was similar to that in adults. Haring *et al*[39] reported that 19.9% of patients with ocular chemical injuries admitted to the emergency department in the United States were children. A study from India reported that chemical injuries were responsible for 3.9% of ocular traumas in children under 14 years of age. Some studies have suggested a higher incidence of serious injury in children[43]. Vajpayee *et al*[40] reported that 85% of ocular chemical injuries in children required surgical intervention and 70.1% of patients had severe sequelae such as limbal stem cell deficiency. In contrast to adults, chemical injuries in the pediatric population are generally associated with domestic accidents, and the most common source of injury varies between diverse studies[44]. The most reported causative agents were domestic chemicals such as detergent capsules, lye, sodium hydroxide, household cleaning products, deodorants, and perfumes in many studies[45]. Haring *et al*[39] reported that the rate of acid-related chemical burns in children was higher than that with alkaline agents. In a study from Turkey, Korkmaz *et al*[46] reported that the causes of the majority (51.6%) of ocular surface injuries in children are unknown or neutral substances.

The incidence of such accidents differs in special age groups depending on the developmental stages of children. Haring *et al*[39] reported that the risk of chemical ocular injury was highest between 1 and 2 years of age and that the rate of alkaline burns was higher in children 3 years of age and younger, in their study involving 143985 patients. A study from the United Kingdom reported that 92.5% of ocular face injuries with detergent capsules occurred in children under 5 years of age[47]. As in adults, the incidence of ocular chemical injuries tends to be higher in boys. Korkmaz *et al*[46] evaluated pediatric chemical eye injuries in the last 10 years and reported that the mean age was 10.4 ± 5.5 years, 27.2% were younger than 5 years old, and 63.6% were boys. Pollard *et al*[48] reported that children aged 4 years and younger experienced eye injuries at a rate of 32% more than other age groups. The profile of causative agents for the geriatric population is similar to that for children, probably due to retirement and spending most of the day at home. Similar to the pediatric population, common agents

of ocular surface injuries in elderly patients are bleach, chlorine, detergent, gasoline, glue, lens cleaner, oil, and paint[49].

Due to the coronavirus disease 2019 (COVID-19) pandemic, a changing trend is detected in the etiology of ocular chemical injury, as in many situations. Contrary to the pre-pandemic data, neutral causes have become more common due to the increased use of alcohol-based hand sanitizers, which is a neutral chemical agent, during the pandemic period[50]. The yearly average of patients with ocular surface burns decreased to 316 patients during the COVID-19 phase as compared to 445 patients during the pre-COVID-19 phase[51]. In a recent meta-analysis, 3 of 5 studies that compared the incidence of chemical eye injuries during the pandemic and control periods, reported a decreased incidence of chemical eye injury during the pandemic period. However, the rate of chemical eye injuries increased among all ocular traumas[52]. Martin *et al*[53] reported that although there was no significant difference in the rate of chemical injuries in children during the pandemic compared to the control period (4% and 5% in 2019 and 2020, respectively), chemical eye injuries due to alcohol-based disinfectants increased from 1 case to 16 cases. Wasser *et al*[54] reported that the incidence of pediatric chemical injury was 36 in 2019, increasing to 72 cases during the pandemic. Furthermore, a significant increase in chemical injuries due to alcohol-based disinfectants was observed. Finally, compared to the pre-pandemic period, ocular trauma remained stable but the proportion of chemical injuries increased by 13.7%[55].

Ethnicity

Although it has been reported in various studies that ocular chemical injuries are more common in Afro-Caribbean, Caucasian, and non-Hispanic ethnicities, a clear relationship between ethnicity and the prevalence of ocular chemical injury has not been identified[56].

CONCLUSION

Ocular chemical injuries are one of the most important ocular emergencies, constituting a significant proportion of all traumas. To minimize sequelae, prompt and accurate treatment in the early period and successful management of complications in the long term are essential. Chemical ocular injuries have significant psychological, physical, and economic effects, especially since serious injuries can cause permanent blindness. The distribution and severity of ocular chemical injuries worldwide vary according to socio-economic conditions, as in all other traumas. In order to prevent further damage due to ocular chemical injury, it is important to understand the epidemiological and demographic characteristics of the injury and take precautions accordingly.

80370_Auto_Edited.docx

ORIGINALITY REPORT

15%
SIMILARITY INDEX

PRIMARY SOURCES

1	Ilayda Korkmaz, Melis Palamar, Sait Egrilmez, Ayse Yagci, Ozlem Barut Selver. "Ten Years of Pediatric Ocular Chemical Burn Experience in a Tertiary Eye Care Center in Turkey", Eye & Contact Lens: Science & Clinical Practice, 2022 Crossref	101 words — 4%
2	Zeynep Akgun, Melis Palamar, Sait Egrilmez, Ayse Yagci, Ozlem Barut Selver. "Clinical Characteristics and Severity Distribution of Tertiary Eye Center Attendance by Ocular Chemical Injury Patients", Eye & Contact Lens: Science & Clinical Practice, 2022 Crossref	85 words — 3%
3	Huiyu Liang, Meiqin Zhang, Man Chen, Timothy P.H. Lin, Mingying Lai, Haoyu Chen. "Ocular Trauma During COVID-19 Pandemic: A Systematic Review and Meta-analysis", Asia-Pacific Journal of Ophthalmology, 2022 Crossref	78 words — 3%
4	Mukhtar Bizrah, Ammar Yusuf, Sajjad Ahmad. "An update on chemical eye burns", Eye, 2019 Crossref	39 words — 2%
5	link.springer.com Internet	27 words — 1%
6	Anthony Vipin Das, Pragnya Rao, Swapna Shanbhag, Swati Singh, Sayan Basu. "Waves of COVID-19	23 words — 1%

Pandemic: Effect on Ocular Surface Services at a Tertiary Eye Center in India", Cureus, 2021
Crossref

7 f6publishing.blob.core.windows.net
Internet
12 words — < 1%

8 www.ncbi.nlm.nih.gov
Internet
10 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE SOURCES	< 10 WORDS
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	< 10 WORDS