Clinical and Experimental Health Sciences

Evaluation of Clinical Findings and Visual Prognosis in Chemical Eye Injuries

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ABSTRACT

Objective: Chemical eye injuries are ophthalmic emergencies that require rapid intervention. It can cause extensive damage to the ocular surface and anterior segment leading to severe visual impairment. In this study, we aimed to report the clinical findings and visual outcomes of patients with chemical eye injuries.

Methods: A total of 59 eyes of 50 patients who were followed up and treated with the diagnosis of chemical eye injury in Marmara University Ophthalmology Department between 2013 and 2020 were included in the study. Demographic and clinical data of the patients were analyzed.

Results: Mean age of patients was 31.9±12.5 (1-55 years). The mean follow-up period of the patients was 21.3±40.9 (median: 13; range: 3-310) days. 74.6% of the injuries occurred in the workplace. The exposed agent was acidic in 47.5%, alkaline in 39.0%, and the agent in 13.5% of eyes was unknown. The mean initial and final BCVA were 0.51±0.44 and 0.09±0.42 LogMAR, respectively. The observed improvement in BCVA values was statistically significant (p<.001). According to the Roper-Hall classification, 62.7% (37) of the eyes were grade I, and according to the Dua classification, 54.9% (43) of the eyes were grade I and II. The two classifications were correlated with each other (p<.001). While medical treatment was sufficient in 94.9% of the eyes, additional amniotic membrane transplantation (AMT) was applied in 3 eyes. conjunctival limbal autograft transplantation combined with AMT was performed in a patient with a grade IV chemical eye injury.

Conclusion: Adequate and timely treatment helps to of paramount importance to mitigate complications. Additionally, staging of ocular surface burns is crucial to determine prognosis and management plan. Chemical eye injuries are often associated with occupational accidents; therefore, preventive measures and workers' education are imperative.

Keywords: Chemical eye injury, Limbal ischemia, amniotic membrane transplantation, Roper-Hall classification, Dua classification

1. INTRODUCTION

Chemical eye injuries are ophthalmic emergencies that require rapid intervention. It can cause extensive damage to the ocular surface and anterior segment leading to severe visual impairment. Approximately 8% – 21% of all ocular traumas were produced by chemical agents (1). In most cases, chemical eye injuries are work-related, due to home accidents, or may be associated with a criminal assault and are overwhelmingly encountered by 20 – 40-year-old males (1). The offending chemical agent can be acidic, alkaline, or neutral. Nonetheless, alkali injuries are the most common and associated with worse consequences. It penetrates deeper tissues due to the lipophilic nature of alkaline agents. On the other hand, acid injuries cause coagulation necrosis, wherein tissue damage is limited (2). The injury's extent and severity depend on the agent type, contact degree, and exposure duration. Various classification schemes for ocular surface burns were developed, which aid in predicting the prognosis of a chemical injury according to the degree of ocular damage. The Roper-Hall classification system is one of the major classification systems based on the degree of corneal haze and limbal ischemia, albeit conjunctival involvement is disregarded (3). This is a crucial drawback of the Roper-Hall classification system since conjunctival injury was shown to effectively predict progression to corneal melting and symblepharon formation, making it a crucial determinant of prognosis (4, 5). Another shortcoming of this classification method is that all injuries with >50% limbal ischemia are lumped together and categorized as grade IV (6). Conversely, Dua et al. 2001 showed that not all burns with 50% – 100% limbal involvement have the same prognosis as indicated

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previously by Roper Halls classification (grade IV), rather patients with total (100%) limbal ischemia were associated with a much worse prognosis than those with just over 50% limbal ischemia. Consequently, the Dua classification was introduced, where Roper Hall's grade IV (>50% limbal ischemia) is stratified into three distinct groups according to the extent of conjunctival injury (5). Factoring in conjunctival involvement is important as this factor is of great prognostic and predictive value in the setting of severe ocular burns (5). Treating chemical eye injuries aims to restore epithelial integrity, control inflammation, and prevent complications. This study reports the clinical findings and visual outcomes of patients with chemical eye injuries.

2. METHODS

This retrospective study reviewed the records of all participants admitted to Marmara University Pendik Educational and Research Hospital with a chemical eye injury between 2013 and 2020. A total of 59 eyes of 50 patients were included in the study. The follow-up time of patients, the offending agent they were exposed to, initial best-corrected visual acuity (BCVA), final BCVA, treatment modalities, and presence of accompanying limbal ischemia and/or corneal haze were recorded. The severity of the chemical injury was determined according to both Roper-Hall and Dua classifications (3, 5). All patients were irrigated at the time of admission. Morgan therapeutic lenses were used in certain cases. In addition to medical therapy, amniotic membrane transplantation (AMT) and conjunctival limbal autograft transplantation (CLAT) were used for patients who did not heal with medical treatment.

2.1. Statistical analysis

The extracted data were analyzed with SPSS (version 22.0, Chicago, USA). Continuous data were expressed as a mean ± standard deviation (SD), while categorical data were described using numbers and percentages. Wilcoxon signed rank test was applied to compare initial and final visual acuities. A p-value of 0.05 or less was considered statistically significant.

3. RESULTS

The mean age of patients was 31.9±12.5 years (range:1–55), and a male predominance was evident (79.6%). The average follow-up duration of patients with acute ocular burns was 21.3±40.9 days (range: 3–310). Work-related trauma (44 [74.6%] eyes) was the most common cause of injury, followed by home accidents (15 [25.4%] eyes). The injuries were right-sided in 20 (40%) eyes, left-sided in 20 (40%) eyes, and bilateral in 10 (20%) eyes. The offending chemical substance was acidic in 47.5% and alkaline in 39.0% of the patients; however, the offending agent was unknown in the remaining 13.5% (Table I). None of patients wore safety glasses at the time of injury.

Table 1. *Prevalence of ocular chemical injuries*

Age (years)	31.88±12.52
Genders (%)	
Male	79.59%
Female	20.41%
Laterality (%)	
Right eye	40%
Left eye	40%
Bilateral involvement	20%
Location (%)	
Workplace	74.6%
Home accident	25.4%
Agent	
Acid	47.5%
Alkali	39.0%
Unknown	13.5%

The mean initial and final BCVA were 0.51±0.44 LogMAR and 0.09±0.42 LogMAR, respectively. The observed improvement in BCVA values was statistically significant ($p < .001$). The mean intraocular pressure at the presentation and final visit were 15.30±2.81 and 14.57±2.09 mmHg, respectively. The healing time of the epithelial defect was 9.40±13.07 days (median: 11, range: 1-90). At first examination, limbal ischemia was observed in 24 (40.6%) eyes (Table 2). After treatment, corneal haze developed in 14 (23.7%) eyes. No correlation was observed between limbal ischemia and corneal haze ($p= .08$). No significant association was found between limbal ischemia and final visual outcome ($p= .37$). Additionally, no significant difference in final visual acuity was observed between the acid and base exposure groups ($p= .62$). There was also no correlation between the disease stage and final visual acuity ($p= .83$). While 56 (94.9%) eyes received only medical therapy, AMT was needed for 3 (5.08%) eyes. A symblepharon ring was used in 6 (10.2%) of the eyes. Autologous serum eye drops were added to the treatment in 16 (27.1%) eyes. Moreover, limbal deficiency developed in patients at an advanced stage despite all treatment options (medical therapy + AMT + CLAT). According to the Roper-Hall classification, 37 (62.7%) eyes were grade I, 14 (23.7%) eyes were grade II, 7 (11.9%) eyes were grade III, and 1 (1.7%) eye was grade IV. Meanwhile, according to the Dua classification, 17 (28.8%) of the eyes were grade I, 26 (44.1%) of the eyes were grade II, 15 (24.4%) of the eyes were grade III, and 1 (1.7%) eye was grade V (Figure I). The two classification schemes correlated with each other ($p < .001$).

Table 2. *Clinical findings of ocular chemical injuries*

Mean Visual acuity (LogMAR)	**Baseline 0.51±0.44**	**Final 0.09±0.42**
Mean Intraocular Pressure (mmHg)	**Baseline 15.30±2.81**	**Final 14.57±2.09**
Mean Healing time of the epithelial defect (day)	9.40±13.07	
Prevalence of Limbal ischemia	24 (40.6%)	

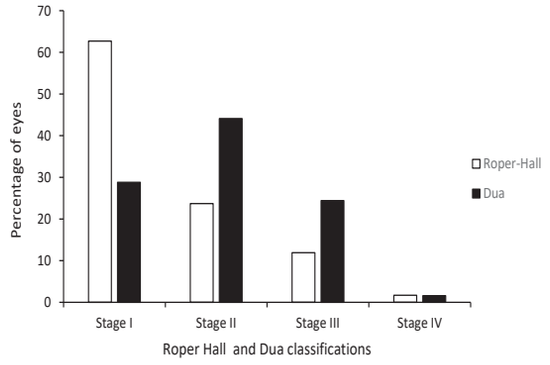

Figure 1. *Distribution of patients by Roper Hall and Dua classification.*

4. DISCUSSION

This study described the characteristics and outcomes of 50 patients treated with ocular chemical injuries. Most of the patients were males, and most of the accidents occurred at the workplace. Acidic agents caused the majority of injuries. According to the Roper-Hall classification, 37 (62.7%) eyes were at grade I. On the other hand, according to the Dua classification, 43 (72.9%) eyes were at grades I and II. Medical treatment was sufficient in 93.2% of the eyes.

Ocular chemical injuries are ophthalmic emergencies that require immediate treatment as they could have devastating effects on the patient's vision, potentially leading to blindness. Adequate management on time of each stage of the disease is necessary to achieve better visual outcome and to prevent complications. Young men (20-40 years old) are reported to be most susceptible to ocular chemical injuries (1). Ghosh et al. examined 110 eyes of 98 patients (average age: 36.5 ±17.1 years) and reported a male prevalence of 60% with 50% of the accidents occurring at work (7). In consistent with previous literature, the average age of patients included in our studied was 31.9±12.5 years (7). Kuckelkorn et al., in their study including 171 patients, revealed that industrial accidents caused 61% of the ocular surface burns, while 37% occurred at home. The cause of the accident was unknown in 3 patients (8). Likewise, our current study also concluded that the workplace was the most common location of accident. Haring et al. reported that alkaline injuries (53.6%) were more common than acid injuries (46.4%) (9). Although alkali injuries occur more frequently than acidic injuries, most injuries in this study were acid-related. This may be ascribed to the fact that 13.6% of the agents were of unknown nature. Prognostic factors reported to be associated with good final BCVA in chemical eye injuries include older age, poor initial BCVA, and irrigation after more than 24 hours (10). Safety glasses and worker education are of paramount importance (10). In present study, none of our patients wore protective goggles at the time of injury. A significant improvement between initial and final BCVA was detected, as reported by previous literature (10). Immediate irrigation to remove chemical agents is crucial to reduce damage (11). All patients in our study immediately irrigated their eyes after injury.

Treatment of ocular chemical injuries begins with adequate and timely irrigation. Irrigation reduces burn severity the need for surgery and improves the visual acuity (12). Medical treatment is mostly sufficient in patients with mild-to-moderate chemical burns, who have a good prognosis. Mainstay therapy controls acute inflammation and facilitates ocular surface restoration. Topical corticosteroid is the primary therapy to control the critical inflammatory reaction. The common choices include dexamethasone 0.1% and prednisolone acetate 1%. It should be preservative-free to reduce additional stress on the damaged ocular surface. Anti-protease therapy such as tetracyclines and ethylenediaminetetraacetic acid helps reduce and prevent corneal ulcers. In addition to its anti-inflammatory effect, AMT accelerates the healing of the corneal epithelium and reduces pain. Once the acute inflammatory reaction is controlled, the goal is to facilitate the recovery of the ocular surface. Preservative-free artificial tears, ascorbic acid, autologous serum, regenerating agent, bandage contact lens, AMT, and free conjunctival autograft are frequently used to heal the ocular surface. Although the ascorbic acid level is higher in aqueous humor, it decreases after chemical trauma. Oral and topical ascorbic acid increases aqueous humor concentration and reduces collagen degradation and corneal ulceration. Cycloplegic agents are added to the therapy to prevent synechiae and control iridocyclitis. Although fluoroquinolones are often preferred for prophylaxis, culture-sensitive agents are added to the treatment in case of infection (11, 13).

Complications of chemical injuries include poor vision, dry eye disease, glaucoma, limbal stem cell deficiency, and corneal scarring. Direct chemical damage to the conjunctiva can lead to scarring, forniceal shortening, symblepharon formation, and cicatricial entropion or ectropion (1). Various techniques have been reported for limbal stem cell transplantation (LSCT), including conjunctival limbal autograft (CLAU), cultured limbal stem cell transplantation (CLET), simple limbal epithelial transplantation (SLET), and limbal allograft, including keratolimbal allografts (KLAL) and living-related conjunctival allograft (LR-CLAL) (14). According to the Dua classification, limbal deficiency developed in only one patient in this study who was at grade V despite medical treatments, AMT, and CLAT. Glaucoma after chemical burns represents secondary, posttraumatic, and open-angle glaucoma. Lin et al. revealed that eyes with high-grade ocular chemical burns are more likely to have glaucoma and require glaucoma surgery (15). None of our patients developed glaucoma. Tenonplasty is one of the surgical options for severe chemical injuries, corneal scleral ulceration, and melting (16). Free conjunctival autografts may be another option when the other eye is not involved (17). The last stage in treating chemical injuries is a comprehensive restoration treatment that includes the treatment of valve, adnexal reconstruction, glaucoma, and cataract (11). However, these complications were not observed in our patients.

Ghosh et al. showed that four patients with Roper-Hall grade IV undergoing early AMT developed limbal stem cell deficiency (7). Eslani et al., in a study involving 60 grade IV patients, showed that adding early AMT to medical therapy did not accelerate corneal epithelialization. No difference was reported between the two groups in terms of final BCVA (18). In our study, while medical treatment was applied to all patients, AMT was applied in cases with delayed epithelial healing. The number of our patients classified as having an advanced stage was low. A total of three eyes underwent AMT surgery; AMT was applied in combination with CLAT in one patient. The remaining 55 eyes were treated conservatively with medical treatments and AMT.

Gupta et al. compared the Dua and Roper-Hall classification schemes (4). They showed that post-treatment corneal clarity was better in grade IV burns than in grades V-VI, and corneal vascularization was more prominent in grades V-VI than grade IV. Moreover, the formation of symblepharon positively correlated with the extent of conjunctival involvement. Therefore, they reported that the Dua classification has a superior prognostic value than the Roper-Hall classification in the setting of severe ocular burns (19). In present study, both classifications correlated with each other. However, there was no correlation between limbal ischemia and corneal haze. This may be related to fewer limbal ischemia areas in most of our patients.

This study had several limitations which were the retrospective nature of the study, the small number of patients studied and the short follow-up time.

5. CONCLUSION

As a result, adequate and timely treatment helps to of paramount importance to mitigate complications. Additionally, staging of ocular surface burns is crucial to determine prognosis and management plan. Chemical eye injuries are often associated with occupational accidents; therefore, preventive measures and workers' education are imperative. Better visual results can be obtained with medical treatment and appropriate surgical options.

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REFERENCES

[1] Singh P, Tyagi M, Kumar Y, Gupta K, Sharma P. Ocular chemical injuries and their management. Oman Journal of Ophthalmology 2013;6(2):83. https://doi.org/10.4103/0974-620X.116624

[2] Wagoner MD. Chemical injuries of the eye: current concepts in pathophysiology and therapy. Surv Ophthalmol. 1997;41(4):275-313. https://doi.org/10.1016/s0039-6257(96)00007-0

[3] Roper-Hall MJ. Thermal and chemical burns. Trans Ophthalmol Soc U K (1962). 1965;85:631-653.

[4] Gupta N, Kalaivani M, Tandon R. Comparison of prognostic value of Roper Hall and Dua classification systems in acute ocular burns. Br J Ophthalmol. 2011;95(2):194-198. https://doi.org/10.1136/bjo.2009.173724

[5] Dua HS, King AJ, Joseph A. A new classification of ocular surface burns. Br J Ophthalmol. 2001;85(11):1379-1383. https://doi.org/10.1136/bjo.85.11.1379

[6] Bizrah M, Yusuf A, Ahmad S. An update on chemical eye burns. Eye (Lond). 2019;33(9):1362-1377. https://doi.org/10.1038/s41433-019-0456-5

[7] Ghosh S, Salvador-Culla B, Kotagiri A, Pushpoth S, Tey A, Johnson ZK, Figueiredo FC. Acute chemical eye injury and limbal stem cell deficiency. A prospective study in the United Kingdom. Cornea 2019;38(1):8-12. https://doi.org/10.1097/ICO.0000000000001739

[8] Kuckelkorn R, Luft I, Kottek AA, Schrage NF, Makropoulos W, Reim M. Chemical and thermal eye burns in the residential area of RWTH Aachen. Analysis of accidents in 1 year using a new automated documentation of findings. Klin Monbl Augenheilkd. 1993;203(1):34-42. https://doi.org/10.1055/s-2008-1045646

[9] Haring RS, Sheffield ID, Channa R, Canner JK, Schneider EB. Epidemiologic trends of chemical ocular burns in the United States. JAMA Ophthalmology 2016;134(10):1119-1124. https://doi.org/10.1001/jamaophthalmol.2016.2645

[10] Li T, Jiang B, Zhou X. Clinical characteristics of patients hospitalized for ocular chemical injuries in Shanghai from 2012 to 2017. Int Ophthalmol. 2020;40(4):909-916. https://doi.org/10.1007/s10792-019-01263-w

[11] Dua HS, Ting DSJ, Al Saadi A, Said DG. Chemical eye injury: Pathophysiology, assessment and management. Eye 2020;34(11):2001-2019. https://doi.org/10.1038/s41433-020-1026-6

[12] Kuckelkorn R, Kottek A, Schrage N, Reim M. Poor prognosis of severe chemical and thermal eye burns: the need for adequate emergency care and primary prevention. Int Arch Occup Environ. Health 1995;67(4):281-284. https://doi.org/10.1007/BF00409410

[13] Salman İA, Gündoğdu C. Epithelial healing in experimental corneal alkali wounds with nondiluted autologous serum eye drops. Cutan Ocul Toxicol. 2010;29(2):116-121. https://doi.org/10.3109/15569521003709558

[14] Yin J, Jurkunas U, editors. Limbal stem cell transplantation and complications. Semin Ophthalmol. 2018;33(1):134-141. https://doi.org/10.1080/08820538.2017.1353834

[15] Lin MP, Ekşioğlu Ü, Mudumbai RC, Slabaugh MA, Chen PP. Glaucoma in patients with ocular chemical burns. Am J Ophthalmol. 2012;154(3):481-485.

https://doi.org/10.1016/j.ajo.2012.03.026

[16] Kuckelkorn R, Redbrake C, Reim M. Tenonplasty: A new surgical approach for the treatment of severe eye burns. SLACK Incorporated Thorofare, NJ; 1997. p. 105-110.

[17] Dua HS, Miri A, Faraj LA, Said DG. Free autologous conjunctival grafts. Ophthalmology 2012;119(10):2189-e2. https://doi.org/10.1016/j.ophtha.2012.06.004

[18] Eslani M, Baradaran-Rafii A, Cheung AY, Kurji KH, Hasani H, Djalilian AR, Holland EJ. Amniotic membrane transplantation in acute severe ocular chemical injury: A randomized clinical trial. Am J Ophthalmol. 2019;199: 209-215. https://doi.org/10.1016/j.ajo.2018.11.001

[19] Gupta N, Kalaivani M, Tandon R. Comparison of prognostic value of Roper Hall and Dua classification systems in acute ocular burns. Br J Ophthalmol. 2011;95(2):194-198. https://doi.org/10.1136/bjo.2009.173724

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