Case Report

Toxic Epithelial Corneal Edema Due to Insulating Material Exposure

Murat ERDAĞ[1,a], Mehmet CANLEBLEBİCİ[2], Ali DAL[3], Hakan YILDIRIM[1], Mehmet BALBABA[1], Orhan AYDEMİR[4]

[1]*Fırat Üniversitesi, Göz Hastalıkları Anabilim Dalı, Elazığ, Türkiye*
[2]*Kayseri Devlet Hastanesi, Göz Hastalıkları Kliniği, Kayseri, Türkiye*
[3]*Mustafa Kemal Üniversitesi, Göz Hastalıkları Anabilim Dalı, Hatay, Türkiye*
[4]*Universal Göz Hastanesi, Göz Hastalıkları Kliniği, Elazığ, Türkiye*

ABSTRACT

In this case series, 19, 21, and 33 years old male patients who complain of blurred vision presented with corneal edema after using insulation material in the workplace. Isocyanate is a raw material used in the production of all polyurethane materials and is used as a basic material in construction and industrial products. We aimed to emphasize that corneal toxicity may be developed due to exposure to diphenylmethane diisocyanate and polymethylene polyphenyl isocyanate, which are used as insulation materials, and that both employees and ophthalmologists should take caution about this rare situation.

Keywords: *Isocyanates, Corneal Edema, Chemical Corneal Injury.*

ÖZ

Yalıtım Malzemesi Maruziyeti Sonrası Oluşan Korneal Toksisite

Bu olgu serisinde, bulanık görme şikayeti olan 19, 21 ve 33 yaşlarındaki erkek hastalar, işyerinde izolasyon malzemesi kullandıktan sonra kornea ödemi ile başvurdular. İzosiyanat tüm poliüretan malzemelerin üretiminde kullanılan bir hammadde olup inşaat ve endüstriyel ürünlerde temel malzeme olarak kullanılmaktadır. İzolasyon malzemesi olarak kullanılan difenilmetan diizosiyanat ve polimetilen polifenil izosiyanat maruziyetine bağlı korneal toksisite gelişebileceği ve nadir görülen bu durum hakkında hem çalışanların hem de göz hekimlerinin dikkatli olması gerekliği bu vaka serisi ile vurgulanması amaçlanmıştır.

Anahtar Sözcükler: *İzosiyanat, Korneal Ödem, Kimyasal Korneal Yaralanma.*

Bu makale atıfta nasıl kullanılır: Erdağ M, Canleblebici M, Dal A, Yıldırım H, Balbaba M, Aydemir O. Yalıtım Malzemesi Maruziyeti Sonrası Oluşan Korneal Toksisite. Fırat Tıp Dergisi 2024; 29(2): 109-111.

How to cite this article: Erdag M, Canleblebici M, Dal A, Yildirim H, Balbaba M, Aydemir O. Toxic Epithelial Corneal Edema Due to Insulating Material Exposure. Firat Med J 2024; 29(2): 109-111.

ORCID IDs: M.E. 0000-0001-8857-994X, M.C. 0000-0002-6554-8021, A.D. 0000-0002-0748-6416, H.Y. 0000-0001-6951-8260, M.B. 0000-0003-1337-459X, O.A. 0000-0003-2191-9297.

Chemical injury of the ocular surface is a common and serious condition that can cause vision loss. Clinical findings show a wide spectrum from mild irritation to vision loss. Among the causes of chemical injury; materials used in household cleaning (detergent, disinfectant, etc.) as well as chemicals used in industry are also seen. The prognosis of eye injuries with chemicals is determined by the type, amount, and contact time of the substance.

Isocyanate is a raw material used in the production of all polyurethane materials and is used as a basic material in construction and industrial products. Three types of isocyanate toluene diisocyanate (TDI), polymethylene polyphenyl isocyanate (PAPI) and diphenylmethane diisocyanate (MDI) are used extensively. It has been stated that isocyanates in vapor form irritate mucosal structures, especially the conjunctiva and respiratory tract (1). Corneal edema due to TDI exposure has been reported previously (2). In the presentation of these cases; We aimed to discuss the mechanism of ocular surface injury after MDI exposure and its approach to this situation.

CASE REPORT

Three male patients, aged 19, 21 and 33 years old, presented to our clinic with the complaint of blurred vision. In the anamnesis of the patients, they worked in an insulation company and were admitted to the hospital after the increased blurred vision and stinging in the eyes. The working environments of the patients were closed areas and the items they used included MDI and PAPI.

In the physical examination of the 19-year-old patient; visual acuity (VA) was 0.5 bilaterally according to the Snellen chart, intraocular pressure (IOP) was 17 mmHg

[a]Yazışma Adresi: Murat ERDAĞ, Fırat Üniversitesi Göz Hastalıkları Anabilim Dalı, Elazığ, Türkiye
Tel: 0424 233 3555 e-mail: mderdag@gmail.com
Geliş Tarihi/Received: 14.04.2023 Kabul Tarihi/Accepted: 17.11.2023

in the right eye and 16 mmHg in the left eye with applanation tonometry. Bilateral corneas were edematous, and occasionally stromal microcysts were observed (Figure 1).

Figure 1. *Edematous cornea and occasionally stromal microcysts are observed.*

Fundus could not be evaluated due to corneal edema. Central corneal tickness (CCT) was 513 µm in the right eye, 526 µm in the left eye (with Compact Touch STS/UBM Ultrasound Biomicroscope from Quantel Medical), and tear break-up time (TBUT) was 13 seconds for the right eye and 12 seconds for the left eye.
In the examination of 21 years old patient; VA was 0.7 in the right eye, 0.6 in the left eye according to the Snellen chart and 16 mmHg with bilateral applanation tonometry. Bilateral corneas were edematous but it was observed that corneal edema was less than first case (Figure 2).

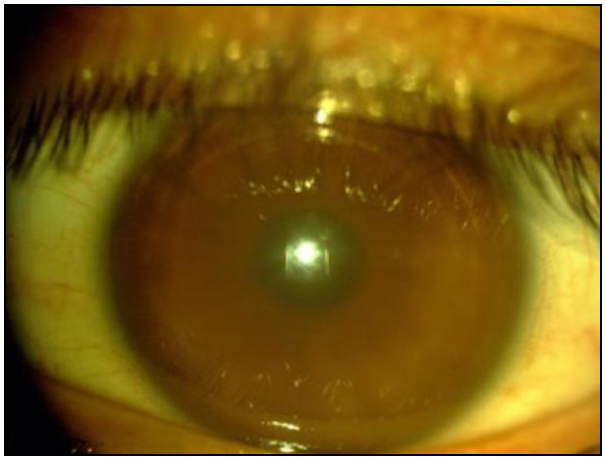

Figure 2. *Epithelial edema on the dome of the cornea.*

Fundus examination was normal. CCT was measured as 530 µm in the right eye, 523 µm in the left eye, and bilateral TBUT was 15 seconds.
For the third patient, who was 33 years old, VA was 0.4 in the right eye and 0.5 in the left eye according to the Snellen chart. IOP was measured as 16 mmHg in the right eye and 18 mmHg in the left eye by applanation tonometry. Bilateral corneas were edematous (Figure 3).

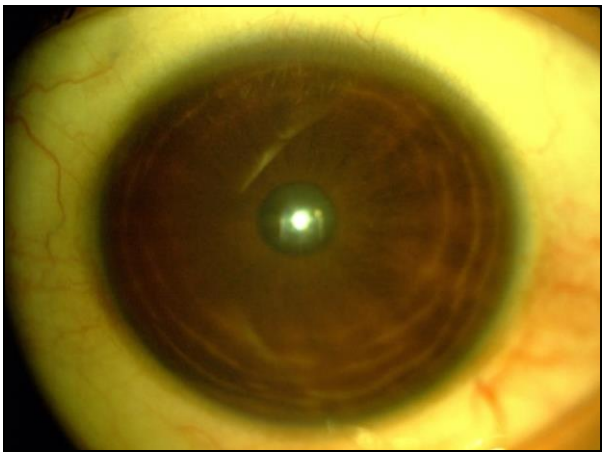

Figure 3. *Minimal corneal epithelial edema of the right eye.*

CCT was measured as 535 µm in the right eye, 547 µm in the left eye, and TBUT was 12 seconds for the right eye and 13 seconds for the left eye.
After obtaining the consent of the patients, they were admitted to Fırat University Department of Ophthalmolgy clinic. To all the three patients; topical steroid (0.1% dexamethasone) was applied 5 times a day, artificial tear (polyvinyl alcohol) was applied 8 times a day and gel (carbomer) was applied bilaterally 5 times a day. On the second day of the treatment, 5% hypertonic ophthalmic solution was applied 5 times per day to the first and third patients due to severe corneal edema. On the 4th day of the treatment, it was observed that the corneal edema of the patients reduced and their visual acuity improved bilaterally. The patients were discharged by recommending outpatient clinic control with same treatment. All the three patients had full visual acuity, their corneas were completely transparent, and there were no stained area on the ocular surface when they were observed in the outpatient clinic controls one month later. CCT was measured as 487 µm in the right eye, 503 µm in the left eye; 512 µm, 508 µm; and 517 µm, 525 µm; respectively.
Written informed consent was obtained from the patients for publication of this case report and accompanying images.

DISCUSSION

MDI can cause serious respiratory diseases such as occupational asthma, hypersensitivity pneumonia or alveolitis, and skin irritation. It is important to use a suitable mask when working with MDI and similar substances that evaporate and can cause toxic effects on sensitive tissues (3). Also, it should be kept in mind that it may affect sensitive tissues such as conjunctiva and cornea. This risk may increase especially for those who work in indoor environments where air circulation is low. In our cases, presenting three patients with similar complaints at the same time suggests that it may be a toxic substance, but if only one patient was affected we might not noticed.

The cornea is a transparent tissue and its continuation depends on the functional of the epithelial and endothelial layers of the cornea (4). Transparency loss due to corneal edema; although it mostly develops as a result of endothelial dysfunction, it may rarely occur due to epithelial and tear film layer disorders. It has been stated that epithelial and endothelial cells provide the balance of corneal hydration by using active energy and the tear film layer contributes to corneal transparency by serving as an oxygen source for the anterior cell layers of the cornea (5). Mishima et al. (6) showed that the tear film layer creates hypertonic osmotic pressure to expel excess dissolved water from the epithelium. Therefore, any defect in energy metabolism in both the endothelial layer and the epithelial layer of the cornea may cause deterioration in corneal hydration and loss of corneal transparency.

The mechanism of corneal edema formation caused by diisocyanates is not fully known yet. It has been reported in corneal edema caused by endothelial cell dysfunction, fluid leaks into the stroma, as a result, stromal thickness increases to approximately 30%, and then epithelial edema occurs (7). Davies et al. (8) showed that diisocyanate impairs endothelial energy metabolism by inhibiting 3', 5'-cyclic-adenosine-monophosphate formation. Since disruptions in corneal epithelial energy metabolism also cause corneal edema, this mechanism should not be ignored in treatment planning. In this case series, we observed there was approximately a 15% difference (less than 30% difference stated in the literature) between pre-treatment corneal thickness and post-treatment corneal turbidity completely disappeared. These data support a deterioration in the epithelial layer rather than a deterioration in the corneal endothelium. We think that people who are engaged in insulation work may develop pathologies related to prospective corneal toxicity, so long-term follow-up of these patients will be useful.

In conclusion, the toxic effect of isocyanates on corneal epithelial metabolism may be the cause of corneal epithelial edema. It should be kept in mind that workers who use protective equipment such as masks and gloves can apply only with eye complaints. In acute bilateral corneal edema, toxic gas exposure should be kept in mind.

REFERENCES

1. Arnold SM, Collins MA, Graham C et al. Risk assessment for consumer exposure to toluene diisocyanate (TDI) derived from polyurethane flexible foam. Regul Toxicol Pharmacol 2012; 64: 504-15.
2. Luckenbach M, Kielar R. Toxic corneal epithelial edema from exposure to high atmospheric concentration of toluene diisocyanates. Am J Ophthalmol 1980; 90: 682-6.
3. Creely KS, Hughson GW, Cocker J et al. Assessing isocyanate exposures in polyurethane industry sectors using biological and air monitoring methods. Ann Occup Hyg 2006; 50: 609-21.
4. Meek KM, Boote C. The organization of collagen in the corneal stroma. ExpEye Res 2004; 78: 503-12.
5. Smelser GK. Relation of factors involved in maintenance of optical properties of cornea to contact-lens wear. Arch Ophthamol 1952; 47: 328.
6. Mishima S. Some physiological aspects of the precorneal tear film. Arch Ophthamol 1965; 73: 233.
7. Ytteborg J, Dohlman CH. Corneal edema and intraocular pressure. II. Clinical results. Arch Ophthamol 1965; 74: 477.
8. Davies RJ, Butcher BJ, O'Neil CE et al. The in vitro effect of toluene diisocyanate on lymphocyte cyclic adenosine monophosphate production by isoproterenol, prostaglandin and histamine, a possible mode of action. J Allergy Clin Immunol 1977; 60: 223.