Ocular trauma. Part 3: chemical injuries

TREVOR J.P. HODSON MB BS, FRACS, FRACO

This month, we conclude our discussion of ocular trauma with a look at chemical injuries, which have the potential to produce severe unilateral or bilateral visual impairment.

Causes and types of chemical injuries

Chemical injuries to the eyes are not uncommon, occurring in both home and work environments. Injuries are usually classified according to the pH of the causative agent as alkaline or acidic, as the two types of agents tend to behave differently when in contact with the ocular surface. Alkali injuries are generally more severe and involve deeper structures such as the corneal stroma and endothelium whereas acid injuries are more often confined to the corneal epithelium.

Alkali injuries

The common agents leading to alkali burns are caustic soda, ammonia and lime, which are found in domestic and industrial cleaners, fertilisers and plaster products. Alkali injuries raise tissue pH, leading to the saponification of lipids in the epithelial cell membranes and, ultimately, to the death of these cells. As a result of damage to the epithelial barrier, alkali compounds can penetrate deeper into ocular tissues, which means that the full extent of an injury may not be apparent for several days.

Acid injuries

Sulfuric acid (battery acid) is the most common acid cause of ocular injury. Sulfuric, hydrochloric and hydrofluoric acid are used in industry.

Unlike alkaline agents, acids tend to cause proteins to coagulate, and the coagulum acts as a barrier against further penetration into the eye (the exception is hydrofluoric acid, which has a greater ability to penetrate tissues). In general, the extent of an acid injury can be determined in the first few hours after injury.

Dr Hodson is an ophthalmologist in private practice at the Mount Gambier Eye Centre, Mount Gambier, SA.

Management of chemical injuries

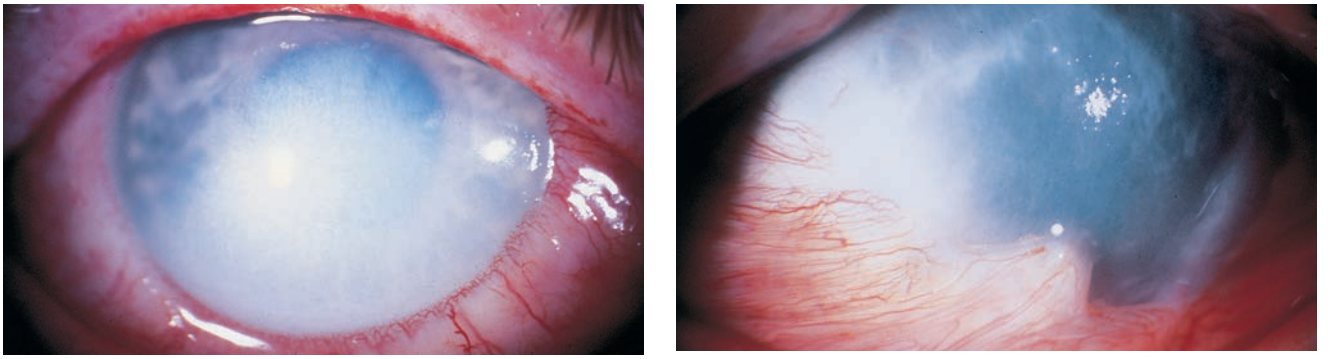
Immediate steps

The first and most important thing to do when a patient presents with a chemical eye injury is to commence immediate irrigation with copious amounts of fluid. This should be continued for at least 10 minutes. In an emergency department, irrigation with saline fluid using a giving set is appropriate, but in a workplace flushing under a tap or at a special fountain is vital.

It may be helpful to instil a topical anaesthetic agent such as amethocaine 1% (Minims) to reduce the patient's discomfort. If a particulate agent such as plaster is involved, it is necessary to evert the eyelids to remove any particles.

Assessment

When irrigation is completed, the eye should be examined thoroughly to determine the extent of the injury. The visual acuity of both eyes should be tested – if unaided acuity is reduced, use a pinhole to see if improvement occurs, and record the result in the notes. A general eye examination should follow. If the corneal epithelium is extensively damaged, drops of local anaesthetic will



Figures 1a and b. Slit lamp photographs of a grade IV chemical injury. a (left). The acute phase. Note the opacification of the cornea and blanching of the limbal blood vessels. b (right). Three months later. Note the persistent corneal opacity and the invasion of the corneal surface by conjunctival epithelium.

help to relieve blepharospasm and allow an adequate examination to be performed. Use of a grading system is recommended (see the box below).

Epithelial damage is assessed with fluorescein dye, which is best done on a slit lamp using a cobalt blue filter. After instilling drops of local anaesthetic, the tip of a fluorescein strip (Fluorets) is dipped in the inferior conjunctival fornix and the patient is asked to blink. Areas of denuded corneal epithelium fluoresce brightly under the cobalt blue light, and the presence of these areas should be documented.

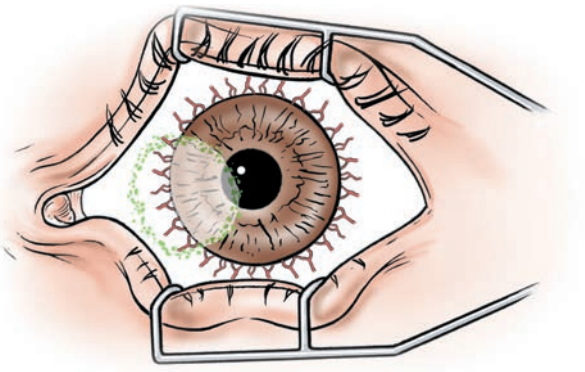
Limbal ischaemia is also documented on the slit lamp, looking for areas where the normal blush of the limbal vessels is lost as a result of coagulation of the vessels by the toxic agent. The extent of the involved limbal circumference should be documented.

Treatment

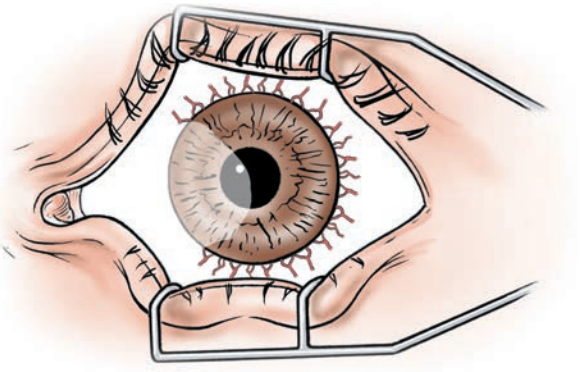
Patients with a grade I or II injury are usually treated with a combination of a prophylactic antibiotic ointment, such as

Using a grading system for chemical injuries to the eye

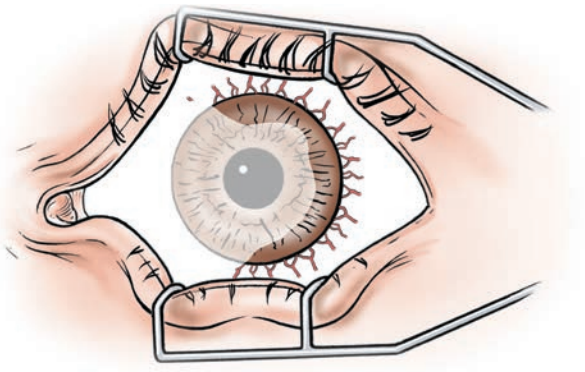
A grading system is recommended for chemical injuries to the eye because it has therapeutic and prognostic implications. The system outlined here, modified after the system proposed by Hughes, classifies injuries in four categories, taking into account the extent of epithelial loss, amount of limbal ischaemia and degree of corneal opacification.



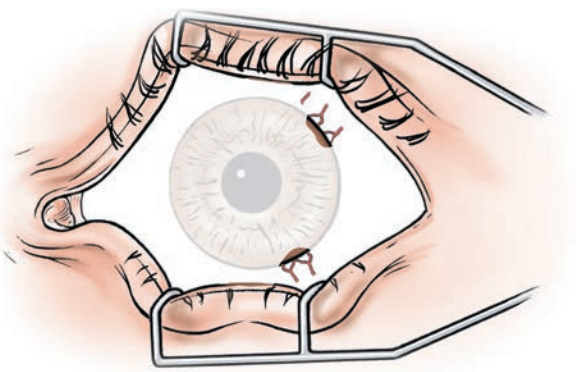
Grade I. Less than one-third of the epithelium is damaged. Punctate or confluent staining with fluorescein may be shown. Limbal ischaemia is not present.



Grade II. Up to one-half of the epithelial damage is damaged, with confluent fluorescein staining. Limbal ischaemia is less than one-third of the circumference.



Grade III. Complete loss of the corneal epithelium, which extends to involve the conjunctival epithelium. Limbal ischaemia is between one-third and one-half of the circumference, and the corneal stroma appears hazy with some blurring of iris detail.



Grade IV. The cornea is opaque, obscuring all of the view of the iris or pupil. Limbal ischaemia is greater than one-half of the circumference.

ILLUSTRATIONS © CHRIS WIKOFF, 2001. ADAPTED FROM HUGHES WF. ARCH OPHTHALMOL 1946; 36: 189-214.

chloramphenicol 0.5% (Chloromycetin Eye Preparations, Chlorsig, Minims), and a cycloplegic agent, such as atropine 1% (Atropt, Minims) or homatropine 2% (Isopto Homatropine, Minims). Oral analgesics will be required initially. The eye may be padded, and patients can generally be treated on an outpatient basis with regular review until the epithelium is intact as demonstrated by fluorescein staining.

Patients with a grade III or IV injury will normally be admitted for pain relief and treatment, with the aim of promoting epithelial healing as quickly as possible (epithelium regenerates from undamaged limbus or remaining islands of corneal epithelium). In addition to the agents listed above (chloramphenicol 0.5%, atropine 1% or homatropine 2%), a topical corticosteroid such as prednisolone (Predsol) or dexamethasone (Maxidex) is added to reduce stromal inflammation and promote epithelial recovery. If the epithelium is not intact after 10 days, caution must be exercised with corticosteroids because there is a risk of producing stromal ulceration and – in some cases – corneal perforation as a result of collagenase activity in the damaged corneal stroma.

Prognosis and referral

Patients with a grade I or II injury normally have a good prognosis. The poor prognosis of more severe injuries arises because of the invasion of the cornea by unstable conjunctival epithelium as well as superficial and deep blood vessels and the replacement of normal clear corneal stroma by opaque scar tissue (Figures 1a and b). Another consequence of these injuries is the formation of adhesions between the surface of the eye and the eyelids (symblepharon).

All patients with a grade III or IV injury should be referred to the care of an ophthalmologist; most grade II injuries should also be reviewed by the same to ensure adequate progress is being made. In the long term, eyes that have been damaged severely by chemical agents may be considered for corneal grafting. However, coexisting damage to the conjunctiva and accessory tear glands often means that these eyes are chronically deficient of tears, making the prognosis for graft survival greatly reduced compared with other indications for corneal grafting.

A final word on prevention

The public should be made aware of the possibility of severe ocular damage from a wide range of agents found in domestic cupboards. Containers should be clearly labelled in regard to their contents and appropriate first aid measures in the event of accidental exposure. Everyone should be aware of the need to irrigate the eyes immediately in the event of any accidental chemical exposure.

In the workplace, appropriate safety measures should be used when handling these agents to reduce the risk of injury, and staff should be educated about how to deal with any accidental chemical exposure. Unfortunately, I am aware of a patient who was recently blinded by accidental workplace exposure to a caustic solution used to clean pipes. Despite immediate irrigation, three weeks in hospital and several operations, the patient lost his sight in both eyes as the result of an accident that could have been avoided. His case is a tragic reminder of what can happen in cases of severe chemical injury and the devastating effect of such injuries. MT