Evaluation and Management of Corneal Foreign Bodies

Arthur H. Keeney, MD, DSc
Louisville, Kentucky

Insults from corneal foreign bodies range from trivial windblown debris through destructive chemicals, penetrating wounds, and severe secondary infection. History and preliminary examination should begin concurrently, particularly in the case of chemically active compounds. Needed auxiliaries are topical anesthetics, oblique light, magnification, sterile sodium fluorescein for diagnostic staining of surface breaks, removal instruments, and topical antibiotics to reduce the potential of secondary infection. A steadied, seated position for the physician, resting posture with hands supported on the face, and an oblique approach tend to reduce the likelihood of unwanted perforations or scars. An irrigating stream of sterile saline delivered through a 25 gauge short needle on a 5 cc syringe will dislodge most recent foreign bodies. The sterile needle is also available as a spud. Corneal thickness varies from slightly above 1 mm in the periphery to less than 0.5 mm centrally. Therefore, it is essential to have clear visualization of the foreign body in relation to corneal depth. Dislodgment into the anterior chamber or incidental perforation of the cornea generally require hospitalization, intensive antibiotics, and steroid therapy.

Complaints

"Something is in my eye!" is a frequent and distressing cry, usually indicating significant pain and functional impairment. The cause may be no more than windblown debris which may be self-removed by blinking, or it can be a perforation of the globe leading to destructive infection of the cornea or intraocular contents. An active chemical crystal, such as a pipe cleaning caustic, may burn an irreparable hole through the eye, whereas an inert chip of plastic or aluminum can be removed in unhurried fashion. The preferred, the sighting, or the better eye is commonly the one aligned and thereby targeted for accidental insult. The tough and transparent cornea is the frontal site most exposed and liable to retain particles. Hot materials coagulate in the cornea more easily than in the softer and wetter bulbar conjunctiva. Treatment is urgent, and it should be based on the history, the findings, and the potential for complications.

From the Department of Ophthalmology, University of Louisville, Kentucky. Requests for reprints should be addressed to Dr. Arthur H. Keeney, Professor of Ophthalmology, University of Louisville, School of Medicine, Louisville, Ky 40201.

Histories: What, When, Where, How, and Previous Eye Diseases

Pertinent history can be obtained while the initial inspection is being performed. The time and circumstances of injury are crucial in planning the extent of examination and evaluating potential complications. Simple windblown debris usually means the particle struck with low velocity and is unlikely to be embedded. A history of machine-shop type activity, such as hammering *steel-on-steel*, raises a potential for deep perforation and immediate consideration of x-ray examination. Working with particulate chemicals poses a threat of acid or alkaline burn and a need for immediate copious irrigation. This should be done on a first-aid basis, with instruction by telephone from whomever answers the physician's office phone. Thus, a chemical splash or chemical particle embedded in the eye means that the telephone receptionist should interrupt further description by the patient and suggest an immediate copious irrigation under a running faucet. The patient should then be advised to call back for instructions when to meet the physician for definitive care.

Where the foreign body accident occurred is also important in determining the types of environmental threat, eg, (1) chemical activity, (2) ferrous particles which would oxidize, or (3) sewer or stable areas with threats of secondary infection. Concurrent activities such as exposure to bright sun and snow (snow blindness), exposure to welding sources or sunlamps without protection, or chemically charged atmosphere should be noted. Remember too, chemical or photic irritations do not preclude a concurrent foreign body.

It is vital to make a brief query concerning previous eye troubles and the wearing of glasses. It should be recorded whether or not the eye of complaint has had previous problems, and if the patient has worn contact lenses. In the latter instance, one should ask whether or not the lenses afforded good and normal vision.

Materials Required

Headrest and Seating: The patient should be provided a comfortable chair with his head placed securely on

a headrest. An examining table is suitable, *if* the physician is comfortable in reaching the eye from the top of the head or the side of injury. In either event, the physician should also be seated for stabilization.

A focal light source of moderate intensity should be brought from one side rather than directly into the eye. Diffuse, bright, or surgical-type lights aimed frontally into the eye intensify ocular pain and produce protective lid closure.

Magnification: The physician preferably should wear a head-mounted or spectacle-mounted loupe, yielding two to three-power magnification. An illuminated stand magnifier is handy in uniting light source and magnification, but it commonly produces irritative, frontal light, and may interfere with hand positions needed to remove foreign bodies.

Topical Anesthetic: Non-irritating anesthetics such as proparacaine hydrochloride (Ophthaine or Ophthetic) have replaced the more irritating tetracaine (Pontocaine) or the more allergenic butacaine sulfate (Butyn). Cocaine is contraindicated because of its tendency to soften epithelium.

Cotton-tipped Applicators: These should be available and sterile for moistening with topical anesthetic. They are particularly suitable for lifting a foreign body from the conjunctiva or upper lid, but are less useful on the cornea where they abrade significantly large, adjacent areas of epithelium.

Sterile Irrigating Saline: A 2 or 5 cc, sterile, disposable syringe with a short 23 or 25 gauge needle should be filled with sterile saline. This provides both an irrigating stream to dislodge foreign bodies and a sterile needle-spud for more embedded particles.

Foreign Body Instruments (Sterile disposable needles, No. 11 Bard-Parker blades, cataract knives, and spuds): Sharp, clean, sterile and rust-free instruments of this type should be available, though not exposed, on the surface of treatment tables or in open glass cabinets. The use of cold sterilizing solutions (eg, Cidex) may be effective against bacteria and spores, but requires irrigation of the instrument with a sterile solution before use. This is generally less desirable than employment of individually wrapped, sterile needles or disposable blades. Handles or fingertip stabilizers[1] facilitate the use of such small instruments.

Sodium Fluorescein Stains: Foreign bodies which are not easily apparent (as in the case of fiberglass or spectacle glass fragments) or which are multiple and old (often seen in the case of miners) must be differentiated from recent and symptomatic foreign bodies. Topical staining with individually wrapped, sterile, dry strips of sodium fluorescein-impregnated paper is very helpful in this regard. The tip may be moistened with a drop of topical anesthetic and merely touched to the outer canthal conjunctiva where the dye will diffuse over the cornea and not require irrigation. Bottles of sodium fluorescein solution tend to grow bacterial contaminants, particularly Pseudomonas aeruginosa, and should not be retained.

Post-Removal Antiseptic Solutions or Drops: These should be antibiotics which are not used systemically, and have a low index of allergenicity.

Post-Removal Dressings: Individually wrapped, sterile, oval eye pads and paper tape should be available.

Examination and Findings

Immediately on approaching the patient, the physician should note evidence of dirt, grime, multiple lacerations, and other facial injuries. Their absence is reassuring but never permits the physician to stop with the discovery of a single offending agent. There is always the possibility of a second or multiple fragments of debris. Examination may not be possible until the instillation of a topical anesthetic (Ophthaine or Ophthetic) and the allowance of a few seconds for surface anesthesia to occur. Further history may be developed during these moments. When the eye can be opened with less discomfort, a preliminary assessment of vision should be made. If the eye is generally intact, a Snellen type of wall chart yields the most standardized information with least effort. Where this is not available, graded near-reading types or even conventional newsprint may be used for an estimate of near visual capability. Remember that the presbyopic patient after the age of 40 usually needs a reading glass, unless he is commensurately near-sighted. If glasses are available, they should be placed in position for preliminary registration of acuity. If vision is grossly impaired or the eye significantly disturbed, note if the patient can count fingers at a distance of a given number of feet. Light on the examiner's hand should be directed from behind the patient. If this is not possible, the patient should be checked for detection of hand movements, similarly specifying the recognition distances as one, two, or three feet. Where there is further loss of acuity, this should be indicated as the localization of a light in space (light projection). The final residual quality of clinical vision is awareness of light perception without projection. Failure to note either a history of reduced vision or reduced acuity at this examination can lead to significant misunderstanding after recovery.

The oblique light source should be adjusted on the eye preferably from a temporal approach. A careful search of the corneal surface is aided by rapid movement of the light source on the eye while the examiner is searching. When the eye is obviously intact and the foreign body is not seen on the available surface, then a quick inspection of the lower cul-de-sac is achieved by drawing the lid downward and outward. This is the common locus for a *dislodged* foreign body to reach. If neither the cornea nor the lower cul-de-sac reveals the offender, then the upper lid should be everted by fingers or over a match stem or applicator handle depressing the upper edge of the tarsal plate. The upper lid lashes are drawn forward between the examiner's thumb and finger simultaneously with depression of the upper edge of the tarsal plate, thus everting the lid. A sulcus (nurse's groove) is seen immediately above the upper lid border, and this is a common place for foreign bodies not embedded in the cornea. Their presence here is indicated by telltale vertical scratches created each time there is a blink of the upper lid. The examiner should be ready to lift off the foreign body from the upper tarsal conjunctiva with a cotton-tipped applicator moistened with topical anesthetic.

When the foreign body is identified as clearly corneal, note should be made as to whether it is superficial or deeply embedded. The presence of a rust ring or discoloration circle about the foreign body indicates chemical oxidation, commonly of iron origin, and suggests that the foreign body has been present for many hours.

Sodium fluorescein staining yields an intense green coloration where the corneal epithelium has been broken or removed. The glass-like and subepithelial Bowman's membrane stains green, whereas breaks or burns of the conjunctiva stain yellow.

Technique in Removal

If not deeply embedded, the foreign body is usually best dislodged with a stream of sterile saline directed obliquely or tangentially through a 24 to 25 gauge needle. If this does not work, a mechanical instrument such as a needle or knife tip should be employed. For this maneuver, the heel of the examiner's hand should be rested on the patient's cheek and the examiner also should be in a seated position. It is manifest folly to position a six-foot examiner on two slender ankles to wave the tip of a sharp instrument freehand over the patient's cornea. Corneal thickness is only 0.5 mm centrally and about 1.1 mm in the periphery.

In using a sharp instrument, it is essential to approach the foreign body along a tangential line rather than by perpendicular thrust. The closer the foreign body is to the geometric center of the cornea, the more easily may the unwary perforate into the anterior chamber. If the foreign body appears to be very deep or posteriorly in the stroma, the operator must assure himself of adequate magnification and personal control to avoid perforating the cornea or displacing the foreign body into the anterior chamber. A foreign body extending partially into the chamber has already established a communicating wound, although it may be serving as an occluder in that potential passageway. These may sometimes be removed with small, smooth, jeweler's forceps, if sufficient material is protruding anteriorly to be engaged with the forceps tips. On rare occasions, a iron-containing or a cobalt-nickle foreign body is of such magnetic responsiveness that removal can be achieved with a hand magnet. This essentially eliminates mechanical problems of pushing the foreign body away from the forceps tips or fragmenting the foreign body, either by forceps closure or use of a steel instrument in removal.

After lifting off the foreign body, any residual rust ring should similarly be lifted with the tip of the needle applied tangentially to the cornea. A ring which is a day or two old may lift out in one piece, whereas more recent stains may fragment and require scraping maneuvers for their removal.

Post-Removal Medication

The momentary satisfaction of having removed a foreign body must be followed by critical search for other foreign bodies and careful lavage of any residual debris on the conjunctiva or in the cul-de-sacs beneath the upper and lower lids. Once this has been done, usual practice dictates the instillation of an antibiotic solution. Sterile ointments offer somewhat longer retention of medication, but should not be used if there are any perforating wounds or irregular shelving breaks into the corneal substance. Under these conditions, small droplets of ointment may remain in the anterior chamber or in the depths of the cornea and may create chemical irritation. The patient should be questioned concerning drug allergy, and any clearly described or possibly imaginary sensitivity should be respected. In general, topical drugs are used, such as gentamicin, polymyxin, bacitracin, or sulfacetamide in descending order of preference. The incidence of sensitization is low (approximately one percent) with these medications. A single instillation is made and, if the break in corneal epithelium is small and superficial, it is probably unnecessary to prescribe additional drugs for home use. Where large and irregular corneal wounds have been produced, it is preferable to continue the topical use of such solutions several times a day for several days.

Traditionally, belladonna or atropine-like drugs were instilled after removal of a corneal foreign body. Such cycloplegics increase sensitivity to light (by dilating the pupil) and impair near vision (by accommodative paralysis). These drugs act more intensively and longer in blond or light-skinned patients. They are not indicated unless considerable corneal manipulation has been done, or there is some evidence of contusion iritis. The effects of these drugs will impair for one day to one week near tasks or stereopsis essential, for example, to riggers or construction workers. They should not be instilled routinely.

Both comfort and epithelial repair (by sliding and mitosis) are facilitated if the lid borders are not permitted to slide up and down over the injury site as in normal blinking. Therefore, a *firm* dressing should be applied for 24 to 36 hours. An oval eye pad should be positioned while asking the patient to keep *both* eyes closed. There should be enough thickness in the pad to create gentle pressure and firm lid closure with tape. A loose eye dressing causes increased mechanical irritation. Therefore, the tape is preferably applied first to the cleansed skin of the brow and brought with traction down over the eye pad. Using two fingers of the opposite hand, the physician should lift the skin of the cheek slightly upward toward the eye as the tape is applied below. On relaxing of the physician's fingers, a small amount of tension is created which is comfortable and supportive to the eye. Three or four strips of one-half-inch tape are usually adequate and should not extend below the masseter muscle or onto the mandibular area. Under such circumstances, chewing either loosens the tape or transmits mechanical irritation to the injured eye. Topical anesthetics should never be given to the patient because all of them delay wound healing.

Follow-up

After removal of superficial foreign bodies, if the patient is understanding, cooperative, and lives nearby, he may be instructed to remove the dressing the following day and to return only if there is pain, swelling, or protracted irritation. If the foreign body has been deep in the stroma or nearly perforating in the central cornea, or there has been gross contamination, it is essential to check the cornea daily until epithelialization has occurred and the eye is relatively asymptomatic. In all cases, the patient must be warned to return if there is any unexpected discomfort or discharge. At the final visit, the physician is also well advised to reconfirm visual acuity in the injured eye. This should be done with the spectacle glass in place, if the patient ordinarily wears such a device for distance use.

Complications and Their Management

Early complications relate to sur-

gical problems in finding or extracting the foreign body. Mechanical dislodgment of the foreign body into the anterior chamber increases the threat of infection and possible need for major ocular surgery for removal. Such foreign bodies may become obscured in the meshwork of the iris or hidden in the peripheral recesses of the chamber. Of similar but slightly less significance is inadvertent perforation of the cornea. This is usually evidenced by a spurt of clear aqueous fluid from the anterior chamber and immediately followed by a forward displacement of the iris and lens toward the cornea. If the perforation is small and clean, reformation may occur in a matter of minutes. When an instrument penetrates the cornea with loss of aqueous, the usual forward movement of lens and iris predisposes the lens to mechanical injury and at least a localized cataract formation at the site of impalement.

Iris incarceration may be caused by sudden forward movement into the wound with the iris acting as a plug. If minute, this perforation may be self-sealing with reformation of aqueous fluid in the chamber. More commonly, this constitutes a major ophthalmic risk, a need for mydriatic or miotic drugs, and frequently a need for hospitalization. If the iris is not incarcerated in the perforation and if the chamber is seen to reform, the patient may be sent home overnight with a pressure dressing, and should be instructed to sleep on his back. These eyes must be followed at daily intervals to insure full pupillary mobility.

Late complications primarily relate to bacterial infection. These commonly become apparent within 48 hours with tenacious secretions and exudates in the conjunctiva, plus grayish or whitish infiltration of the cornea about the site of injury. Such eyes should be left open, cleansed frequently during the day, and treated with antibiotic solution instilled once or twice per hour. If there is any level of debris suggestive of purulency in the anterior chamber, the patient will probably require hospitalization and periocular injection of antibiotics as well as topical medication. Delayed infections, as with fungi, may not appear for ten to 20 days and then present a major therapeutic challenge.

Endophthalmitis of either bacterial or later fungal origin is highly destructive to the sensitive rod and cone cells of the retina. Intensive periocular injections and intravenous therapy may arrest the infection but seldom prevent serious damage to the percipient cells of the retina. Such major inflammations are usually indicated by haziness in the aqueous and vitreous of the eye, paralleling progressive loss of sight.

Scars result from perforation of the glass-like Bowman's membrane immediately beneath the epithelium. Any transgression of this level produces some permanent scarring. Similarly, manipulations and penetrations into the stroma usually leave telltale opacities. Final visual impairment, however, relates particularly to (1) location of the scar in reference to the visual axis, and (2) final smoothness and curvature of the corneal surface. Of course, scarring from deep infection in the cornea tends to produce permanent opacities which may later need corneal transplantation for their relief.

Reference

1. Weaver JH: A needle stabilizer for corneal foreign body removal. Trans Am Acad Ophthalmol Otolaryngol 75:660-661, 1971