Chapter 10

TRAUMA OF THE CRYSTALLINE LENS

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INTRODUCTION

An estimated 2.4 million ocular injuries occur annually in the United States; of these, 40,000 to 70,000 are serious and vision-threatening. In the setting of ocular injury, injury to the crystalline lens is a frequent and serious consequence of both blunt and penetrating trauma. The National Eye Trauma System (NETS) reports that traumatic cataract occurs in 10% to 40% of reported cases of penetrating ocular trauma.[1] Lens injuries occur in approximately 25% of cases of blunt injury of the globe.[2,3]

In the battlefield setting, the majority of wartime injuries are caused by fragmentation weapons. One third of wartime ocular injuries are corneoscleral lacerations, and associated lens damage is common,[4] occurring in an estimated 27% to 50% of such cases.[5] During the Persian Gulf War, traumatic cataract comprised 9% of reported serious ocular injuries.[6]

Traumatic damage to the crystalline lens has diverse manifestations (Exhibit 10-1). In blunt trauma, the coup–contrecoup theory[7] and the equatorial expansion model[8] account for such diverse injuries as contusion cataracts, capsular disruption, and zonular disruption with resultant subluxation and even dislocation of the lens. Penetrating trauma resulting in anterior and/or posterior capsular disruption can induce a rapid opacification of the lens. Intraocular foreign bodies (IOFBs) can become lodged within the lens itself or cause toxicity through oxidation. Liberation of lens material in both blunt and penetrating trauma can lead to intraocular inflammation and elevation of intraocular pressure (IOP).

EXHIBIT 10-1

MANIFESTATIONS OF TRAUMA TO THE CRYSTALLINE LENS

- Contusion cataract
- Rosette cataract
- Vossius ring
- Complete lens opacification
- Intralenticular foreign body
- Posterior capsular rupture
- Lens involution/Soemmering ring cataract
- Lens subluxation
- Lens dislocation
- Lenticular inflammation/elevated intraocular pressure

Traumatic damage to the lens occurs secondarily to osmotic hydration or dehydration. When the osmolarity of the lens is subject to large variations, a cataract develops. Traumatic laceration of the lens capsule or injury to its adenosine triphosphate–dependent sodium–potassium ion pump results in increased permeability, allowing an influx of sodium and water from the aqueous into the substance of the lens, producing intracellular and extracellular swelling of epithelial cells. Additionally, lens proteins undergo proteolysis, aggregation, and conformational changes, all thought to be factors responsible for lens opacification in acute traumatic cataracts. Capsular integrity is rapidly restored, and—even in the case of observable perforation—opacification may remain localized or even reverse as fibrin seals off the capsular tear.[9] However, the opacity is irreversible once lens fiber swelling and fragmentation occur.

Extremes of heat and cold, electrical shock, and radiation exposure also lead to irreversible protein conformational changes and lens opacification. In cases of significant capsular laceration, the entire lens can rapidly opacify, but the large majority of cataracts in blunt trauma remain localized and morphologically distinct.

BLUNT TRAUMA

Contusion Cataract

A contusion cataract is usually a partial or localized opacification of the lens. It forms days to weeks after the injury and is often transient. The opacification in a contusion cataract is usually stationary and impacts vision in ways that depend on its relationship to the visual axis. Subcapsular opacities may organize into focal, scattered, punctate lesions, or they may coalesce into larger lamellar opacities (Figure 10-1). The morphologic appearance of a concussively induced cataract is often so characteristic as to be diagnostic of previous trauma, even in the absence of a definite history of trauma.

Fig. 10-1. Contusion cataract. Focal traumatic cataract in young man who sustained blunt trauma as a result of being struck by a rock. Although the opacities are focal, their central location caused disabling glare.

An archetypal form of contusion cataract is the rosette (Figure 10-2). A rosette radiates from the central nuclear sutures to the periphery and forms as fluid shifts take place inside an intact capsule. Rosette cataracts are very often visually significant because of their central location. A rosette will occasionally occur years after a traumatic event (Figure 10-3).

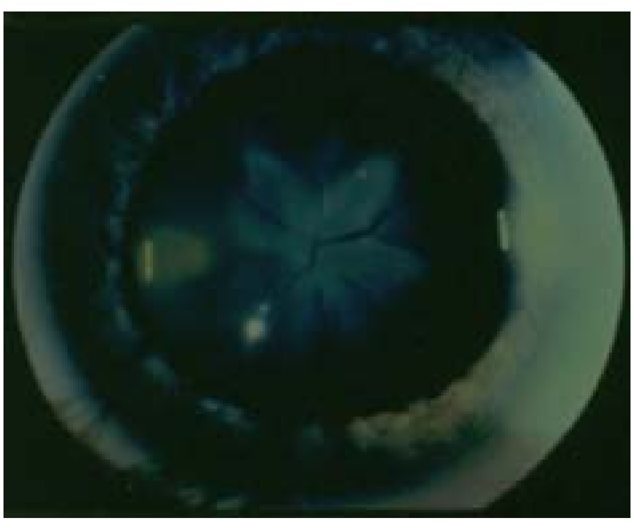

Fig. 10-2. A characteristic rosette cataract seen after blunt trauma, pathognomonic for contusion injury to the lens.

Vossius Ring

A contusion injury may lead to an imprint of pigment from the pupillary border onto the anterior face of the lens. This pigment, termed a Vossius ring, is seen most commonly in young patients and often slowly resolves over time.

Lens Subluxation

The sudden anteroposterior deformation of the globe experienced in severe blunt trauma is associated with rapid circumferential contraction and expansion of the globe. This mechanism accounts for concussive disruption of the iris root, ciliary body, zonules, and even the lens capsule. A subluxation of the lens is a partial zonular dehiscence, with

a

b

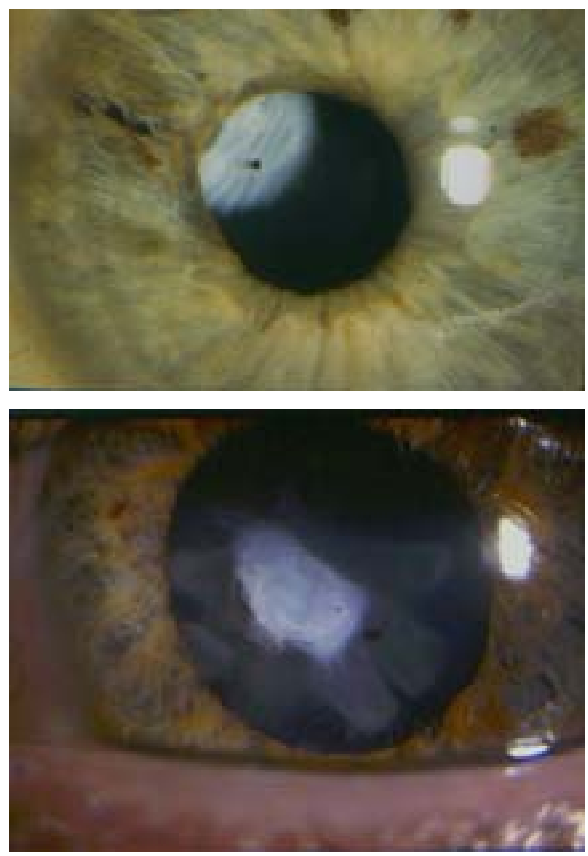

Fig. 10-3. Progressive traumatic cataract. (**a**) A focal paraxial contusion cataract, seen here 20 years after blunt injury to the eye (hit with a rock); vision is 20/20. (**b**) Three years later, a rosette cataract developed, dropping vision to 20/200. Rosette formation can occur years after injury, as it did in this case.

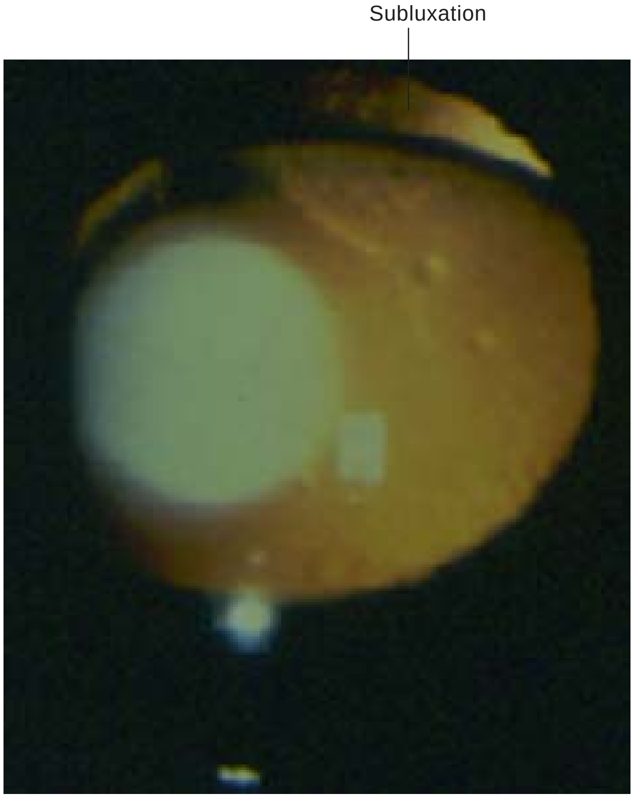

Fig. 10-4. Subluxation of the crystalline lens occurs when a minimum of 25% of the zonules are compromised.

the lens remaining in the pupillary aperture. This phenomenon can cause induced astigmatism, increased myopia, or increased anterior chamber depth. Subluxation occurs when 25% of the zonules are ruptured.

A subluxed lens will often go unnoticed at the time of injury (Figure 10-4), but the presence of iridodonesis or vitreous prolapse into the anterior chamber may indicate its presence. Patients with lens subluxation may complain of fluctuating vision as the lens shifts position, or of monocular diplopia if the lens equator reaches the visual axis.

Lens Dislocation

Lens dislocation occurs only in the setting of a complete zonular dehiscence. Dislocation can allow forward displacement of the lens, causing pupillary block, or even total entrapment in the anterior chamber. The lens can also settle posteriorly and peripherally in the anterior vitreous base. This difficult-to-visualize location may raise the possibility of lens egress from the eye if the globe is open. Rarely, the intact crystalline lens may actually be displaced outside the globe through a limbal rupture, where it becomes deposited subconjunctivally (Figure 10-5).[10,11]

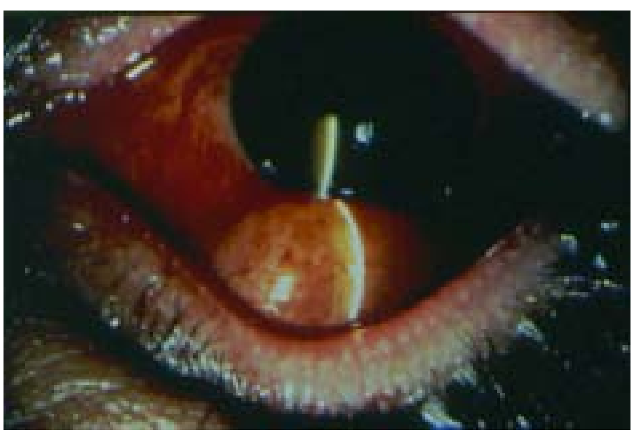

Fig. 10-5. This photograph demonstrates a crystalline lens deposited in the subconjunctival space following globe rupture. When the lens has been totally dislocated from its normal anatomical position, a careful, dilated peripheral posterior segment examination should be performed to determine whether the lens remains intraocular. Its presence will often be revealed in the far-equatorial anterior vitreous.

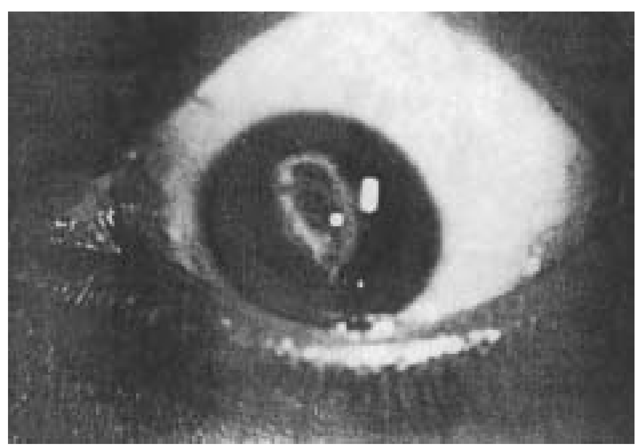

Fig. 10-6. Fibrosed edges of posterior capsular break seen after blunt trauma. Contusion injury may result in isolated posterior capsular breaks because the posterior capsule is thinner, anatomically, than the anterior. Reproduced with permission from Thomas R. Posterior capsular rupture after blunt trauma. *J Cataract Refractive Surg.* 1998;24:284.

Posterior Disruption

Rapid equatorial expansion of the globe sometimes causes a tear or break in the lens capsule. The posterior capsule, which is the thinnest, is often the site of rupture. Capsular tears may occur in conjunction with zonular disruption or as an alternative to it. Two distinct presentations of posterior capsular rupture have been described (Figure 10-6).[12,13] A Type 1 tear is a break in the capsule with thick, fibrous opaque margins and associated posterior capsular opacification. A Type 2 tear, on the other hand, has thin, transparent margins without associated lens opacification.

Differences in the two types of capsular breaks appear to be time dependent. When surgical intervention was delayed (1 mo–2 y postinjury), lenses show Type 1 tears, with clinical evidence of attempted healing of the defect. This type of capsular break does not tend to enlarge intraoperatively. When early surgical intervention is required (3–7 d postinjury), lenses exhibit Type 2 tears, which behave similarly to fresh intraoperative breaks. Type 2 tears tend to enlarge during irrigation or aspiration and need to be managed by viscoelastic plugging, dry aspiration, and adequate vitrectomy.

PENETRATING TRAUMA

Anterior Capsule Injury

In perforating wounds in which the lens capsule is directly injured, a large proportion of cases show localized and morphologically distinctive opacities rather than rapid, generalized opacification. Histologically, a cap of fibrin forms over the rent and the local epithelial cells rapidly degenerate, but neighboring subcapsular epithelium soon grows over the defect. These cells eventually decrease in size and become replaced by a homogeneous matrix, which then becomes covered by normal epithelium, which secretes a hyaline membrane.

If the tear occurs in the region of the iris, the reconstitution of the injured area is reinforced by fibroblasts from the iris tissue, and sometimes pigment from the iris is incorporated in the scar. In this way the tear can be completely and rapidly closed. Even with an observable tear, the preliminary local clouding of the lens may disappear if the tear itself is rapidly sealed off by fibrin while the imbibition of fluid is still reversible.[14] If a tear is larger and compromise of the lens capsule exceeds its mechanisms for repair, a rapid and complete opacification of the lens will occur (Figure 10-7).

Lens Absorption (Involution)

In younger patients, usually in the first decade of life, a laceration of the anterior lens capsule can result in an intense inflammatory response with

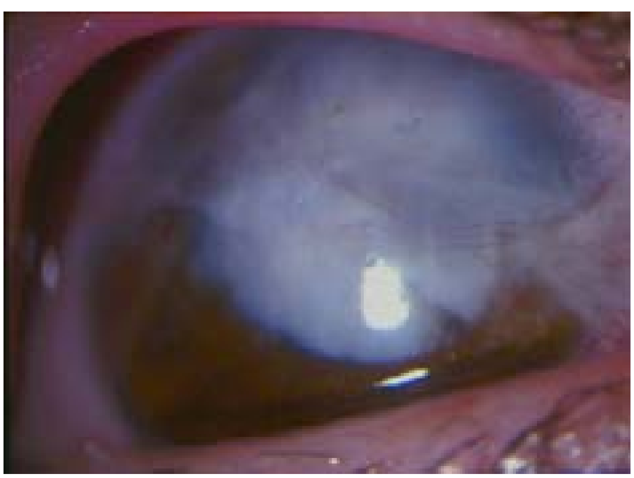

Fig. 10-7. Penetrating trauma often results in combined injury of the anterior segment. Corneal lacerations are commonly seen with concomitant anterior capsular disruption. Rapidly progressive or delayed lens opacification may result, as it did in this case of penetrating trauma from needle-nosed pliers.

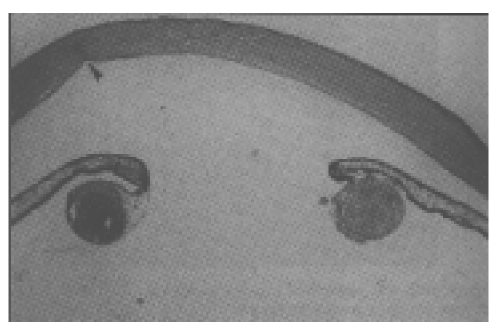

Fig. 10-8. Soemmering's ring cataract developed in this patient following penetrating corneal laceration (arrow). Reproduced with permission from Streeter BW. Pathology of the lens. In: Albert DM, ed. *Principles and Practice of Ophthalmology.* Vol 4. Philadelphia, Pa: WB Saunders; 1994: 2208.

Fig. 10-9. This patient, a 24-year-old man, sustained blunt trauma to his eye with anterior capsular rupture. Despite minimal inflammation, his lens material spontaneously involuted, leaving behind a Soemmering's ring cataract (arrow) and an "aphakically" corrected eye with 20/20 vision.

spontaneous absorption of the entire lens nucleus, rendering the eye aphakic. Typically, a remnant of lens capsule and cortex will remain, forming a yellow-white ring called a Soemmering ring cataract (Figure 10-8).[15] Laser capsulotomy can aid in clearing of the visual axis, and treatment of aphakia can render excellent visual correction (Figure 10-9).

Intraocular Foreign Body

When a traumatic foreign body enters the eye, a cataract can be induced by either direct injury to the lens or through the toxic action of oxidized metal. Products of oxidation slowly invade the lens and produce characteristic lens discoloration or opacification. Sunflower cataracts arise from copper-containing foreign bodies (chalcosis; see Figure 15-11 in this textbook) and brown discoloration from iron deposits of the capsular epithelium (siderosis lentis; also see Figures 15-3 and 15-4). Cilia, glass, and nonoxidizing metals can occasionally enter the lens and may be well-tolerated for long periods with only localized opacification (Figure 10-10).[16]

Lenticular Glaucoma

Lens-induced inflammation results from the release of lens proteins into the anterior chamber. In the setting of a hypermature cataract, this release can occur through microscopic leaks in the lens capsule (ie, phacolytic glaucoma). After traumatic laceration of the capsule, macroscopic lens particles are liberated into the aqueous and may elicit a macrophage response, with subsequent deposition of high-density lens material and bloated macrophages in the trabecular meshwork. Medical therapy is required to control inflammation and check acute rises in IOP. The severity of the glaucoma is proportional to the amount of free cortical material in the aqueous humor.[17] Eyes with preexisting decreased outflow facility are more likely to develop increased IOP with lens protein in the aqueous.[18] Lens-particle-induced inflammation and IOP management often require urgent extraction of the lens to restore the eye to its normal state.[19]

In the setting of lens subluxation or dislocation, a mobilized lens can move forward, producing pupillary block with angle closure. With a complete dislocation of the lens posteriorly, the pupil may become blocked with vitreous, which can also produce a pupillary-block, angle-closure glaucoma.[19] Treatment of this form of glaucoma is directed at relieving the pupillary block, often with laser

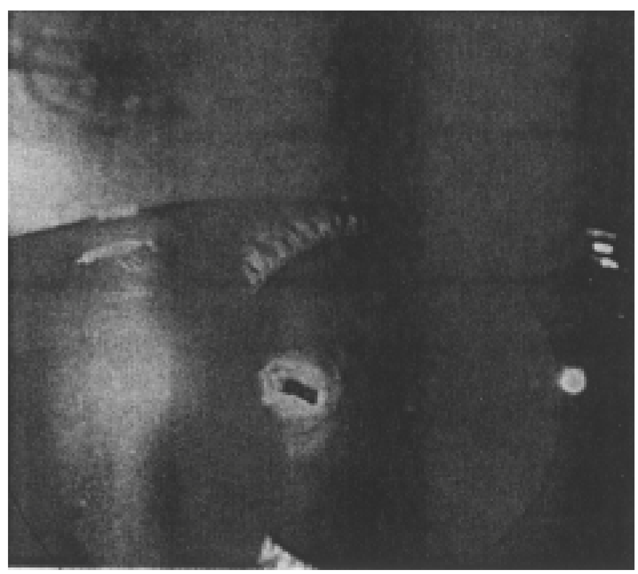

Fig. 10-10. The glass particle, seen here in the anterior lens capsule, remained stable and inert for 10 years since injury; the patient's vision remained 20/20. Reproduced with permission from Cowden JW. Anterior segment trauma. In: Spoor TC, Nesi FA, eds. *Management of Ocular, Orbital and Adnexal Trauma.* New York, NY: Raven Press; 1988: 48.

iridotomy or surgical iridectomy. Lensectomy should be undertaken only when other methods of visual rehabilitation prove unsuccessful or if pupillary block recurs. Occasionally a trauma-induced cataractous lens becomes intumescent. Such swollen lenses can subsequently cause angle-closure glaucoma as a result of pupillary block or result in direct-angle compromise by mass effect.[15]

EVALUATION

History

In the setting of ocular trauma, the mechanism of injury is a critical determinant of the type of the ocular damage sustained and is, therefore, the cornerstone of the medical history. In the battlefield setting, explosions account for the majority of ocular injuries, many of which are sustained concurrently with other major trauma. Fragmentation injury can cause both blunt and perforating ocular trauma, depending on the size of the fragment and the velocity at which it reaches the eye. Timing of the injury is also important.

Although a perforating injury most often brings about immediate evaluation, many patients who have sustained blunt trauma to the globe and develop contusion cataract or lens subluxation do not seek immediate medical care. They may later develop inflammation or experience a delayed onset of fluctuating or decreased vision from subluxation of the lens or progressive cataract. A past medical history should be obtained to establish any preexisting ocular or systemic conditions, such as glaucoma, previous ocular surgery, or diabetes, that may affect outcome.

Examination

Examination of the patient with eye trauma should always begin with the determination that the patient has stable respiratory and cardiovascular systems. Only then should attention be turned to the eye. The eye examination begins with assessment of the vision. In many cases of ocular trauma, the visual acuity on presentation is a predictor of visual outcome.[20]

Establishing whether media opacities or retinal or optic nerve pathology is responsible for visual loss is of immediate importance. Opacification of the lens can progress rapidly after the traumatic insult, and the initial evaluation may provide the only opportunity to evaluate the posterior pole. Retinoscopy can help detect an unsuspected shift in astigmatism or myopia in the case of a subluxed lens. A subtle subluxation may only be identifiable using a retroillumination biomicroscopic view after wide dilation. A deep anterior chamber and iridodonesis may be suggestive of subluxation, and a narrowing of the angle may indicate forward displacement of the lens. Prolapse of vitreous into the anterior chamber confirms the presence of lens subluxation. If corneal edema or blood in the anterior chamber preclude visualization of the lens, ultrasound can be useful in determining its position (Figure 10-11). If lenticular opacification prevents visualization of the retina, B-scan ultrasonography can be used to evaluate vitreous hemorrhage or retinal detachment. Ultrasound is also helpful in determining the presence of a foreign body.

A low IOP is potentially helpful in determining the presence of a ruptured globe, whereas an elevated pressure can indicate subluxation of the lens with pupillary blockade, disruption of the angle, the inflammatory effects of lens particles, or angle closure secondary to an intumescent lens.

When severe ocular injuries are seen with associated head and facial trauma, radiographic studies may be indicated. Plain film radiography can be useful in localizing foreign bodies, and a computed tomography (CT) scan is ideal for defining bony anatomy of the orbit and offers a greater deal of precision in foreign body localization. A CT scan

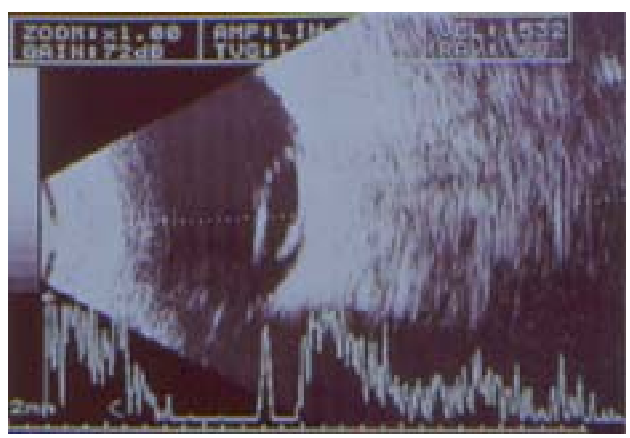

Fig. 10-11. After blunt trauma, the dislocated crystalline lens was visualized using B-scan ultrasound. Corneal edema precluded viewing with indirect ophthalmoscopy.

can also provide information about the state of lens opacification. Signal attenuation may be seen in a lens that is cataractous, even before clinical lens opacification.[21]

SURGICAL MANAGEMENT

After the casualty has been stabilized, the ophthalmologist's attention is directed to the management of ocular trauma. There are a few indications for immediate surgical intervention for isolated lenticular injury:

- dislocation of the lens into the anterior chamber with corneal touch,
- pupillary block due to anterior lens displacement,
- angle closure secondary to an intumescent lens,
- uncontrollable inflammation, and
- elevation of IOP secondary to lens-particle release.

Initial surgical intervention for lens injury can generally be delayed; further evaluation and monitoring are usually indicated. With a localized, eccentric contusion cataract, pharmacological therapy can be tried first to decrease pupil size and clear the visual axis. If the lens is markedly subluxed, miosis can render a patient effectively aphakic, and the vision can then be improved with a contact lens.

Surgical management is indicated for the emergent indications previously described, or it can be offered electively for visual rehabilitation. Elevated IOP and any inflammation should be fully treated before any elective cataract removal. The primary consideration when planning surgical removal of a traumatic cataract or a subluxed lens is the possibility of vitreous loss.[19]

To optimize the surgical outcome and minimize complications, a decision must be made between an anterior (limbal) and a posterior (pars plana) surgical approach. An anterior approach is preferred to remove a traumatic cataract in the presence of an intact posterior capsule or if the lens has been dislocated completely into the anterior chamber. A posterior approach is preferable if the posterior capsule has been ruptured, if the lens is dislocated posteriorly, or if there is a traumatic rupture of the zonules with vitreous presenting anteriorly. Removal of a minimally subluxed lens can be made through a limbal incision; however, anterior vitrectomy and a possible conversion to a pars plana incision may be required. If a lens has been completely dislocated out of the visual axis and is causing no inflammation or elevation of IOP, surgical removal can be delayed indefinitely.

Anterior Approach (Limbal Incision)

An anterior approach to traumatic cataract or traumatic subluxation is indicated in the following situations:

- lens opacification with no apparent zonular compromise and an intact posterior capsule,
- lens opacification with minimal zonular compromise, no displacement of the lens, and no vitreous present in the anterior chamber, and
- dislocation of the lens into the anterior chamber.

Many ocular injuries occur in younger people, and their opacified lens material is relatively soft and easy to remove. If the capsule and zonules are intact, performing a capsulorrhexis is identical to standard cataract surgery. Small compromises in the anterior capsule can potentially be converted directly into a capsulorrhexis. If compromise of the posterior capsule or zonules is occult and a conversion to extracapsular surgery is needed, relaxing incisions can be made at 3 o'clock and 9 o'clock in the capsulorrhexis.[20] It is common in trauma-related cataract surgery that previously unrecognized compromises in the zonules or capsule become manifest during surgery, and the surgeon should anticipate the need to modify the procedure as a case progresses. It is very important to make an adequately sized capsulotomy so that if extracapsular delivery is necessary, expression of the nucleus does not lead to further disruption of the zonules and prolapse of the vitreous.

A standard limbal approach is as follows. Create limbal entry sites at the limbus at the 10 o'clock and 2 o'clock positions. Opposing incisions allow manipulation of the globe, and bimanual technique allows both for finer control of aspiration and for the lowest possible amount of irrigant, which minimizes hydration of the vitreous cavity through any potential zonular interruption. In a lens with intact zonules, a capsulotomy is fashioned with bent-needle cystotome and continued with capsular for-

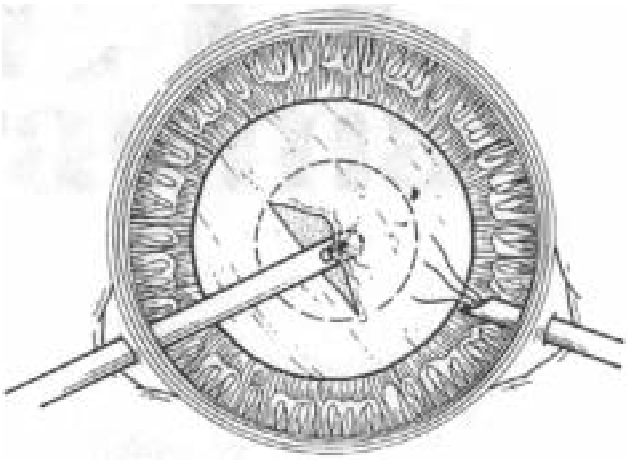

Fig. 10-12. If visualization is poor because of opacification of the lens cortex or if zonular compromise limits the ability to perform capsulorrhexis, an anterior vitrector can be introduced through a capsular opening and used to easily create a well-defined anterior capsulotomy. Reproduced with permission from Irvine JA, Smith RE. Lens injuries. In: Shingleton BJ, ed. *Eye Trauma.* St Louis, Mo: Mosby–Year Book; 1991: 131.

ceps. If visualization is poor, the capsulotomy is fashioned using a can-opener technique with the cystotome, or it can be augmented with Vannas scissors.

When an adequate red reflex is lacking, visualization of the capsule can be enhanced with an off-axis light with a retinal light pipe. Alternatively, a capsulotomy can be started with a Ziegler knife or MVR (micro-vitreo-retinal) blade, and an anterior vitrectomy handpiece that is introduced through the nasal incision is used to cut away the central anterior capsule (Figure 10-12). During mechanical capsulorrhexis, generous use of viscoelastic is advisable to stabilize the anterior capsular plane of the lens and to aid in visualizing the full extent of any capsular tears. Iris retracting hooks can be used to further visualize the lens to the equator, or they can be placed in the advancing tear of a capsulorrhexis to provide countertraction of the capsular bag in areas of zonular weakness.

In a young patient, whose lens is soft, lens removal is performed with the aspiration port of the anterior vitrectomy unit. A separate infusion port is placed through the 2 o'clock incision, using a 23-gauge butterfly needle for chamber maintenance. Maximum aspiration of 150 mm Hg is usually sufficient. In an older patient with more-advanced nuclear sclerosis, routine phacoemulsification may be performed. Careful attention should be given to performing a hydrodissection of the lens with balanced salt solution through a small-gauge cannula. This procedure enables manipulation and removal of the nucleus to be completed with a minimum of traction on the zonules. After removal of the lens nucleus, cortical removal is performed. Manual aspiration through a fine cannula allows carefully controlled cortical removal and can even be performed in areas of zonular dehiscence.

An intracapsular fixation ring (mfg by Morcher, Munich, Germany) is now available that can be placed into the equator of the capsular bag before lens removal. By distributing tension over 360°, countertraction is provided in areas where weak or missing zonules do not provide sufficient tension for adequate stripping of the cortex. Using a curved cannula, bending the cannula, or switching limbal entry sites can all aid in cortical removal in areas of the lens nucleus that are difficult to access, such as under the iris at the 12 o'clock position.

Efforts should be made to ensure that no vitreous is present in the anterior chamber. Viscoelastic tamponade may be helpful in preventing vitreous

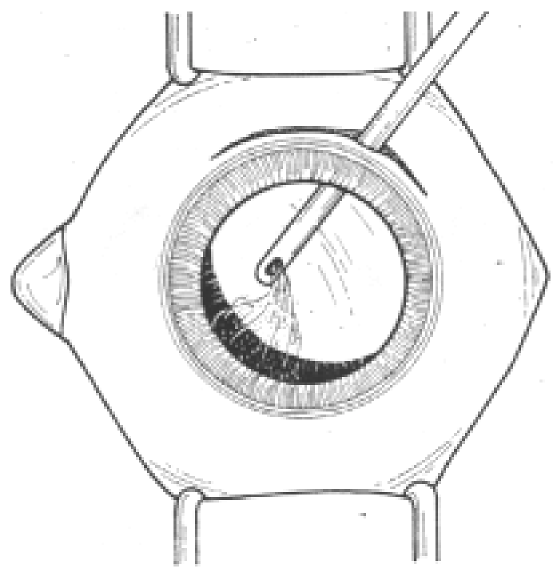

Fig. 10-13. Vitreous presenting into the anterior chamber through an area of zonular compromise should be removed before surgically approaching the lens. Limiting irrigation as much as possible minimizes hydration of the vitreous. A separate site for irrigation may facilitate anterior chamber stability. After vitreous cleanup, viscoelastic is used to tamponade further anterior migration of vitreous. Reproduced with permission from Cohen A, Hersh PS, Fleischman JA. Management of trauma-induced cataracts. *Ophthalmic Clinics of North America*. 1995;8:641.

prolapse in areas of known zonular dehiscence. If partial subluxation of the lens is present and vitreous has presented into the anterior chamber, a vitrectomy should be performed before the lens is removed (Figure 10-13). A separate infusion port is used, keeping the anterior chamber formed with the least amount of fluid possible. If lens removal has been completed, then an intracameral miotic should be instilled, and peaking of the pupil may indicate that vitreous is presenting to the incision. Air can be infused to replace fluid in the anterior chamber to aid in visualization of vitreous strands. A cyclodialysis spatula is introduced through the limbal incision and is used to sweep from the angle toward the pupil in order to free the vitreous strands from the incision site (Figure 10-14). Further vitrectomy and repeated sweeping might be needed to completely free the trapped vitreous strands. If lens material has fallen posteriorly, it is inappropriate and even dangerous to attempt anterior removal of the lens pieces.[22]

Rarely, when a lens is dislocated anteriorly into the anterior chamber and is abutting the endothelium, a topical miotic should be instilled preoperatively and then intracamerally through a limbal paracentesis to prevent posterior migration of the lens. Viscoelastic is injected to protect the corneal endothelium. In a younger patient, the lens can be removed entirely by cutting and aspirating with a vitrectomy handpiece. If the lens is more sclerotic, the limbal incision is extended and the lens delivered intracapsularly through the extended incision. An irrigating vectus can be used to aid expression of the lens. The incision is then closed using interrupted nylon sutures (Figure 10-15).

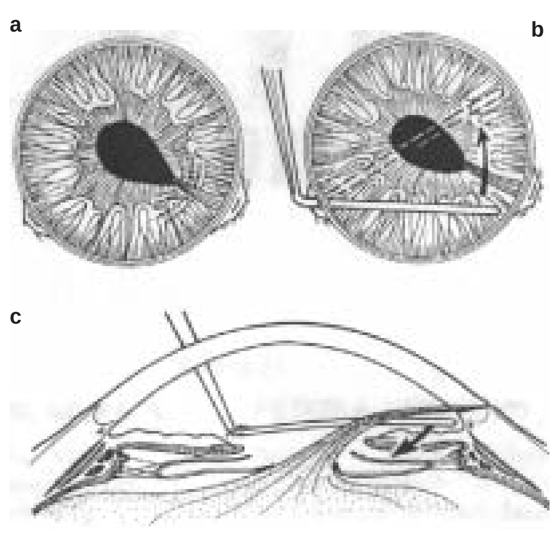

Fig. 10-14. Sweeping of vitreous with cyclodialysis spatula. (**a**) After introduction of an intracameral miotic, constriction of the pupil reveals peaking secondary to vitreous presenting to the wound. (**b, c**) The vitreous may be removed from the angle by passing a sweep or spatula from the opposite port. This procedure may be done under fluid, air, or viscoelastic material. Reproduced with permission from Irvine JA, Smith RE. Lens injuries. In: Shingleton BJ, ed. *Eye Trauma.* St Louis, Mo: Mosby–Year Book; 1991: 132.

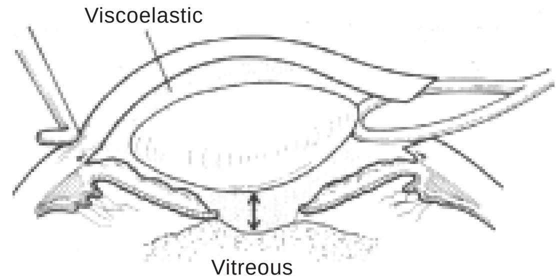

Fig. 10-15. Pharmacological miosis aids in trapping the anteriorly dislocated lens in the anterior chamber, thereby preventing posterior migration. Lens removal then may be achieved via aspiration or limbal delivery. Reproduced with permission from Cohen A, Hersh PS, Fleischman JA. Management of trauma-induced cataracts. *Ophthalmic Clinics of North America.* 1995;8:642.

Posterior Approach (Pars Plana Incision)

A pars plana technique and a posterior approach can be used if there is posterior subluxation or dislocation of the lens or disruption of the posterior capsule with lens fragments in the anterior vitreous.

The following is a standard pars plana approach. A limbal peritomy is performed, allowing for sclerotomies at 10 o'clock, 2 o'clock, and the inferotemporal positions. With an MVR blade, sclerotomies are made 3 mm posterior to the limbus, allowing for a passive infusion port at the inferotemporal position. Care must be taken in placing the infusion cannula, as lens opacification may interfere with adequate visualization of the port, and subchoroidal infusion of irrigating fluid may occur. The bottle height of the balanced salt solution irrigant is adjusted to maintain appropriate chamber depth and IOP.

Twenty-gauge instrumentation is used to perform a core anterior vitrectomy and lensectomy of posteriorly displaced lens materials (Figure 10-16). A bimanual crushing of harder nuclear material (Figure 10-17) may be necessary in older patients,

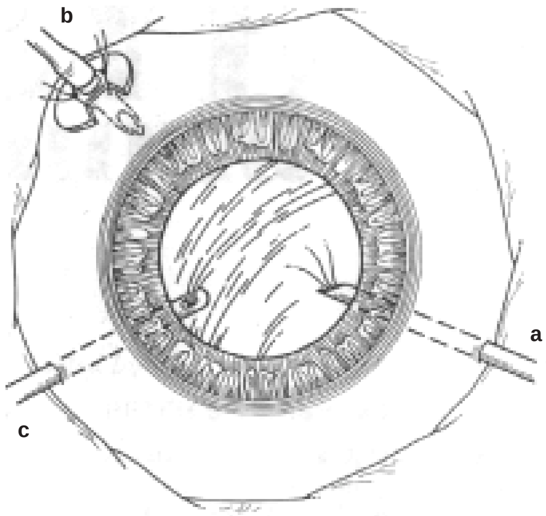

Fig. 10-16. Placement of instrumentation for pars plana lens removal. Sclerotomies are made 3 mm posterior to the limbus. (**a**) The supranasal incision may be used temporarily for a handheld infusion until (**b**) the infusion cannula is sewn into place infratemporally. (**c**) The cutting tip is introduced via the supratemporal sclerotomy. Site "a" can then be used for a second instrument to permit bimanual manipulation of the posterior segment. Reproduced with permission from Irvine JA, Smith RE. Lens injuries. In: Shingleton BJ, ed. *Eye Trauma.* St Louis, Mo: Mosby–Year Book; 1991: 133.

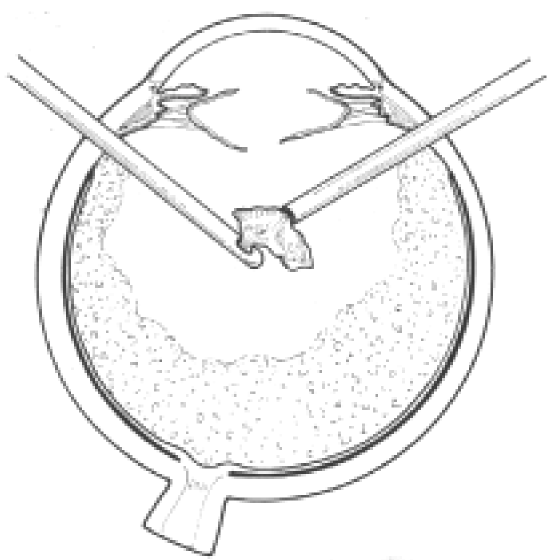

Fig. 10-17. Gentle suction brings posteriorly dislocated lens fragments to a midvitreous location where they can then be removed by a bimanual crush technique or with an ultrasound fragmatome. Reproduced with permission from Cohen A, Hersh PS, Fleischman JA. Management of trauma-induced cataracts. *Ophthalmic Clinics of North America*. 1995;8:643.

or an ultrasonic fragmatome may be required. Contact between lens material and the retina should be assiduously avoided. A limited core vitrectomy is usually adequate, and any lens pieces that are close to the retina should be aspirated off the cushion of remaining vitreous and removed in the midvitreous.[19] Cautious cortical and capsular removal should be performed with the vitrector, with careful attention to leaving behind a ring of capsular remnant to provide for intraocular lens (IOL) support in the sulcus.

Primary Intraocular Lens Placement

The timing of lens removal in the setting of coexisting ocular trauma is controversial. Primary surgical management is often dictated by the extent of corneal and scleral injury in addition to the injury to the lens. When the lens alone is injured, delayed removal has been favored historically.[8] Arguments against acute lens removal include the following:

- the extent of visual compromise can be difficult to assess accurately,
- acute trauma is often repaired by relatively inexperienced surgeons, and
- emergency trauma can take place in a less-controlled setting (eg, after hours, with fatigued operating teams).

Nevertheless, experience is increasing with early lens removal and primary or secondary IOL placement, and numerous reports suggest good results.[23–27] Once the decision to remove the lens has been made, the judgment as to whether to leave the patient aphakic must be weighed carefully against the placement of a primary IOL. Reluctance about placing an implant at the time of primary repair and lens removal is based on the concern that the IOL will be a nidus for infection and a potential aggravant of intraocular inflammation.[28] Some surgeons[29] believe that an implant potentiates the risk of posttraumatic glaucoma, but others[30] refute this claim. A pseudophakic eye can also be more difficult to operate on if further posterior segment repair becomes necessary after the original anterior segment restoration.[31] Advocates[23–35] argue that there is minimal risk of increased posttraumatic endophthalmitis from a sterile implant, that increased inflammation and glaucoma have not been observed, and that posterior segment surgeons are becoming more experienced with procedures on pseudophakic eyes.

Fig. 10-18. Traumatic cataract and lens subluxation with primarily repaired corneal laceration. At primary closure of this corneal laceration (due to knife injury), the lens was noted to be clear. By 6 months later, a posterior subcapsular cataract (PSC) had developed, and inferonasal subluxation was apparent. Cataract surgery planning was complicated by elevated intraocular pressure secondary to angle disruption; irregular corneal curvature, which made keratometry measurement problematic; and lens opacification, which disrupted measurement of axial length with A-scan biometry.

When planning cataract removal and lens implantation in an eye with concurrent corneal injury, the status of the cornea must be taken into account. It is sometimes impossible to obtain keratometry and axial length measurements because of corneal scarring and irregularity and the poor quality of biometry through an opacified lens (Figure 10-18). Measurements of the nontraumatized eye can guide selection of the lens implant.

Choices for lens fixation include (*a*) in-the-bag, (*b*) sulcus-fixated, and (*c*) anterior chamber lenses. In patients whose eyes have small posterior breaks, direct in-the-bag fixation can be considered without scleral fixation; alternatively, single haptic fixation may be adequate. In patients with incomplete posterior capsule support, posterior chamber IOLs can be implanted with both haptics transsclerally fixated. However, this technique causes more damage to the eye and may lead to more complications.[32] An anterior chamber lens may be considered as a preferable option, depending on the status of the iris and the cornea. Ultrasound examination before surgery can reveal the status of the posterior capsule and aid in optimal decision making with regard to IOL implantation, anterior vitrectomy, or prevention of retinal detachment.[36]

POSTOPERATIVE COMPLICATIONS

Surgery to repair a traumatic cataract has a higher rate of postoperative complications than standard cataract surgery does. The loss of lens material into the posterior segment is the most commonly encountered intraoperative complication.[20] Loss of zonular support or enlargement of posterior capsule breaks can contribute to this risk. Lens material should be left in place for spontaneous absorption or for secondary removal through a pars plana approach.

Bleeding from a ciliary body is a risk when sulcus-fixated lenses are placed. Postoperative complications include hyphema, transient IOP elevation or transient hypotension, posterior iris synechiae, iris capture, subluxation of lens implant, endothelial cell loss, and cystoid macular edema.

SUMMARY

Lens injury is a frequent consequence of trauma to the eye. Blunt injury can result in contusion cataracts, either acutely or as late sequelae of the trauma. Disruption of the zonules can result in subluxation and dislocation of the lens. Penetrating trauma often results in combined anterior segment laceration and traumatic cataract. Management of lens injury and timing of surgery are based on location and morphology of the lens opacity, stability of vision, presence of intraocular inflammation, IOP control, and ability to examine the posterior segment. Modern advances in microsurgical techniques have enhanced the results of lens removal. Primary IOL implantation has achieved excellent visual results in an increasingly large number of patients. Careful examination and accurate diagnosis are critical in surgical decision-making, both in the choice of the most appropriate timing for surgery and the selection of the best surgical technique.

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