Every cataract surgeon should have a game plan for when and how to perform an anterior vitrectomy following posterior capsule rupture. This chapter will review the goals, the indications, and the techniques of an anterior vitrectomy. Understanding and mentally rehearsing these strategies will better prepare cataract surgeons to make correct decisions amidst the stress of an unexpected complication.

**Managing Posterior Capsular Rupture—A Step-by-Step Approach**

**Step 1. Attempt to Avoid Vitreous Loss Following Posterior Capsular Rupture.** In many instances with a torn posterior capsule, it is possible to avoid rupturing the hyaloid face. The surgeon must avoid immediately withdrawing the phaco tip upon recognizing a posterior capsular defect. This abruptly unplugs the incision and allows the anterior chamber to collapse. The sudden posterior pressure gradient will rupture an intact hyaloid face, and vitreous will prolapse to the incision, expanding the capsular rent in the process. This undesirable cascade of events can be averted by filling the anterior chamber with a dispersive ophthalmic viscosurgical device (OVD) such as Viscoat (Alcon, Fort Worth, TX) or Healon D (AMO, Santa Ana, CA), prior to removing the phaco tip. Dispersive OVDs are preferable to cohesive OVDs in the face of a capsule tear. This is because dispersive OVDs are better at maintaining space and resisting aspiration during phacoemulsification and irrigation/aspiration ([I/A] see Chapter 11). As the dispersive OVD is injected through the side-port opening, the surgeon moves from foot pedal position 1 to 0. Once the chamber is filled with OVD, the posterior capsule cannot bulge forward as the incision is unplugged. If one resumes phacoemulsification or cortical cleanup, the same maneuver must be repeated whenever the instruments are removed.

**Step 2. Manage the Nucleus Following Posterior Capsule Rupture.** Early recognition of posterior capsule rupture is the key to avoiding a dropped nucleus. It is much easier to remove the nucleus while it remains anterior to the posterior capsule defect. Because they approach the nucleus from above, subsequent
instrument and fluidic forces will eventually expand an unrecognized capsular defect enough to allow the nucleus to sink posteriorly.

One must often rely upon indirect clues to recognize a posterior capsular defect because the iris and the nucleus obscure the zonular and posterior capsular anatomy. Sudden deepening of the chamber with momentary expansion of the pupil, the transitory appearance of a clear red reflex in the periphery, and the inability to rotate a previously mobile nucleus can all indicate capsular or zonular rupture. More obvious and ominous signs would be excessive tipping or lateral mobility of the nucleus or partial posterior descent of the nucleus.

If the remaining nucleus or fragments can be elevated into the anterior chamber with a dispersive OVD, one can insert a trimmed Sheet's glide through the phaco incision to serve as an artificial posterior capsule, as described by Marc Michelson.1 The glide can prevent lens material from dropping posteriorly and will shield the phaco tip from aspirating vitreous from below. The incision should be slightly widened to accommodate inserting the phaco tip above and alongside the glide. Maneuvers of the phaco tip should be minimized to avoid simultaneously moving the glide. This is one advantage of using bimanual microincisional phaco instrumentation through separate 1.2-mm side ports in this situation if the surgeon is adept at this technique.

Step 3. If Necessary, Rescue the Partially Descended Nucleus, Using the Viscoat PAL Technique.

How far the nucleus initially descends through a capsular defect will depend upon the vitreous anatomy. If the vitreous is too liquefied, the nucleus will rapidly sink to the retina, precluding any response by the cataract surgeon. Alternatively, the nucleus may partially descend onto an intact hyaloid face (Figure 6-1). Such slight posterior displacement can be very subtle. Finally, if the hyaloid face is ruptured, the nucleus may tip or partially descend until it is suspended and supported by formed vitreous. In this situation, a rescue technique may be possible.

Although tempting to do so, the worst tactic for recovering a partially descended nucleus is to try to chase and spear it with the phaco tip. Lacking the normal capsular barrier, the posteriorly directed irrigation flow will flush more vitreous forward, expanding the rent and propelling the nucleus away. Attempting to emulsify or aspirate the nucleus may ensnare vitreous into the large diameter phaco tip. Applying suction and ultrasound following vitreous incarceration can produce a giant retinal tear.

The safer alternative is to elevate the nucleus into the pupillary plane or anterior chamber from below. There are numerous obstacles to doing this, however. First, the pupil or capsulorrhexis diameter may be quite small, which may have predisposed the eye to capsular rupture in the first place. A small pupil or capsulorrhexis can impede elevation of a large nucleus and make it particularly difficult for a viscoelastic cannula to maneuver behind it. Prolapsed vitreous will further hinder such attempts to inject OVD beneath the nucleus. The nucleus may suddenly sink if these maneuvers induce further vitreous loss and prolapse.

Charles Kelman, MD, popularized the posterior assisted levitation, or “PAL,” technique in which a metal spatula, inserted through a pars plana sclerotomy, is used to levitate the nucleus into the anterior chamber from below.2 Compared to the phaco incision, a pars plana sclerotomy provides a much better instrument angle for getting behind the lens. Richard Packard and I subsequently published our results of using Viscoat and the Viscoat cannula to support and levitate the nucleus—the so-called Viscoat PAL technique.3 After opening the conjunctiva and applying light cautery, a disposable microvitreoretinal
(MVR) blade (Alcon, Katena) is used to make a pars plana sclerotomy located 3.5 mm behind the limbus. An oblique quadrant should be selected, and these steps can be performed under topical anesthesia. The Viscoat cannula is then advanced and aimed behind the nucleus under direct visualization. The first step is to inject a bolus of dispersive OVD behind the nucleus to provide immediate supplemental support (Figure 6-2). Periodic palpation of the globe confirms that overinflation has not occurred. If the nucleus is subluxated laterally, directing OVD toward the region beneath it will often buoy the nucleus toward a more central position. This is preferable to blindly probing with a metal spatula. One should not attempt to float the nucleus into the anterior chamber using a massive infusion of OVD alone. Unlike using liquid perfluorocarbon in a vitrectomized cavity, an excessive injection of viscoelastic may overinflate the globe and cause vitreous expulsion through the sclerotomy.

Instead, the cannula tip itself should be used to mechanically prop and levitate the nucleus into the anterior chamber (Figure 6-3). Small aliquots of additional dispersive OVD can be injected to help in the elevation and maneuvering of the nucleus. A small capsulorrhesis or pupil will stretch to accommodate the levitation of a greater diameter nucleus. The use of the dispersive OVD to first support and then to reposition the nucleus prior to definitive manual levitation is a major advantage of the Viscoat PAL variation. Because there is no aspiration involved, these PAL maneuvers should minimize iatrogenic vitreous traction and reduce the chance of touching the retina with a metal spatula tip.

Once a fragment descends into the mid or posterior vitreous cavity, it is dangerous to blindly fish for it with any instrument. One should abandon the dropped nucleus and concentrate on removing the residual epinucleus and cortex, while preserving as much capsular support as possible. A thorough anterior vitrectomy must be performed prior to inserting the IOL. Since the vitreoretinal surgeon will later use a three-port fragmatome and vitrectomy technique to remove any retained nucleus, it is preferable to insert an IOL through the cataract incision during the initial surgery if possible.

Step 4. “Trap” Residual Lens Material in the Anterior Chamber and Manage Vitreous Loss Using a Dispersive OVD. Any residual nucleus retrieved with the Viscoat PAL technique can be removed using either of two techniques—resuming phaco over a Sheen’s glide or converting to a large incision manual extracapsular cataract extraction. At some point during this sequence, the phaco or I/A tip may ensnare prolapsing vitreous. To avoid vitreous traction, the surgeon must stop to perform an anterior vitrectomy before extraction of the remaining lens material can be resumed.

The most common practice is to place a separate self-retaining irrigating cannula though a limbal paracentesis and to insert the vitrectomy probe through the phaco incision. However, there are multiple drawbacks to this approach. First, the phaco incision is too large for the sleeveless vitrectomy instrument. This leaking incision affords poor chamber stability and
allows both irrigation fluid and vitreous to prolapse externally alongside the vitrector shaft. Second, performing the vitrectomy in the anterior chamber will tend to draw more posteriorly located vitreous forward. Finally, as more and more vitreous exits the eye through either the cutting instrument or the incision, the residual lens material that it was supporting will sink down toward the retina. It bears repeating that once the posterior capsule is open, it is the vitreous that is preventing the remaining nucleus and epinucleus from descending.

I have proposed a strategy, called the “Viscoat Trap” that, when combined with a pars plana anterior vitrectomy, can prevent this undesirable chain of events. The first step is to use a dispersive OVD, such as Viscoat or Healon D, to levitate any mobile lens fragments upward toward the cornea. Next, one completely fills the anterior chamber with OVD. Even though vitreous has already prolapsed forward, injecting OVD should not exert traction on the retina. The dispersive OVD can now support and trap the residual lens material in the anterior chamber as the vitreous is excised from below (Figure 6-4).

The Viscoat Trap is so named because of the need to employ a dispersive OVD. To effectively trap lens material, the OVD should be maximally retentive during conditions of high fluid movement. Dispersive OVDs, such as Viscoat and Healon D, resist aspiration by an I/A device or by a vitrectomy device more effectively than do cohesive OVDs. Moreover, the smaller size and molecular weight of dispersive agents makes a prolonged and protracted pressure spike less likely when small amounts are retained.  

Step 5. **Perform Anterior Vitrectomy Using Bimanual Pars Plana Approach.** As with the Viscoat PAL, the pars plana sclerotomy is made 3.5 mm posterior to the limbus and can be performed under topical anesthesia. A disposable #19 MVR blade will create an adequately sized opening for most anterior vitrectomy cutters and should be advanced until it is visualized through the pupil. A self-retaining irrigating cannula is placed through a limbal paracentesis and angled toward the pupil. As described by Scott Burk, staining prolapsed vitreous with a triamcinolone suspension to improve visibility is an option, but I find that it is usually not necessary in this situation. The sleeveless vitrectomy shaft is inserted through the pars plana sclerotomy until the tip can be visualized in the retropupillary space. If it does not pass through the incision easily, it is important to slightly enlarge the opening rather than to force the entry. Utilizing low flow and vacuum settings, and as high a cutting rate as possible to minimize vitreous traction, a thorough anterior vitrectomy is performed. One should focus posteriorly enough with the microscope to keep the tip under direct visualization at all times. One should attempt to keep the vitrectomy tip behind the plane of the pupil if possible. While any transpupillary bands of vitreous will still be severed, this will avoid removing the dispersive OVD that fills the anterior chamber (Figure 6-5). When properly performed, one will see that the anteriorly trapped lens fragments remain immobilized as the vitrectomy is being carried out from below. This is because two separate chambers have been formed by the OVD partition, such that the anterior chamber is isolated from the vitrectomized posterior chamber. Using a pars plana sclerotomy is an underutilized option when performing an anterior vitrectomy. The principles of anterior vitrectomy technique are the same: one must not aspirate vitreous without cutting it, one should keep the vitrectomy tip under direct microscopic visualization, and one should not attempt to retrieve lens material that is in the

![Figure 6-4. Following anterior vitreous prolapse, the residual lens fragments are elevated toward the cornea, where they are trapped by filling the anterior chamber with Viscoat.](image)
posterior vitreous cavity. The main advantage is that using a properly sized sclerotomy will decrease incisional leak and vitreous prolapse and should provide a better fluidic seal. Unlike with a limbal incision, the vitrector need not traverse the anterior chamber and disrupt the dispersive OVD partition, and it will not draw more vitreous forward into the anterior chamber. Performing the vitrectomy posterior to the plane of the pupil and capsulorrhexis also decreases the chance of inadvertently cutting either structure. If the capsulorrhexis is preserved, a foldable posterior chamber IOL may still be implanted in the ciliary sulcus. The sclerotomy can be closed with a single interrupted 8-0 Vicryl suture.

Following the retropupillary anterior vitrectomy, one can resume aspiration of the remaining cortex or epinucleus trapped in the dispersive OVD-filled anterior chamber (Figure 6-6).

Step 6. **Bimanual I/A of Residual Cortex.** Once the capsule or zonules have ruptured, bimanual I/A instrumentation is ideal for epinuclear and cortical extraction for several reasons. Access to subincisional cortex is improved. The tighter paracentesis incisions better restrain vitreous from prolapsing compared to using the phaco incision. Finally, this is a lower flow fluidic system compared to coaxial I/A. This permits the surgeon to work in “slow motion” by lowering the irrigation bottle and decreasing the aspiration flow and vacuum settings. If the aspirating ports again become entangled with vitreous, one can repeat the Viscoat Trap maneuver followed by additional pars plana anterior vitrectomy. Bimanual cortical I/A can then be resumed.

Step 7. **Implant IOL Following Anterior Vitrectomy.** If the capsulorrhexis is still intact, a three-piece foldable or nonfoldable posterior chamber IOL can be placed in the ciliary sulcus. After the haptics are first positioned in the sulcus, the optic should be captured behind the capsulorrhexis if possible. This will ensure excellent centration because the optic cannot move. First, one side of the optic is tilted back and beneath the capsular rim before repeating the same maneuver for the other side. This maneuver can be very challenging following a vitrectomy, however, and may not be possible if the capsulorrhexis diameter is too large.

If the capsulorrhexis is not intact, there may still be enough capsular support to put the posterior chamber IOL in the sulcus. Amidst the stress of managing an unexpected complication, some surgeons use the same foldable posterior chamber IOL they were planning to implant in the capsular bag. This is not recommended for several reasons. First, moving the axial IOL position slightly forward changes the effective power of the lens; you need to decrease the power by about 1 diopter to compensate for this position change. Second, nearly all foldable lenses are 13.0 mm or less long, which is too small for the ciliary sulcus in many eyes. Although the lens may center well in the operating room, if it is too short, it can eventually rotate and subluxate peripherally over time.
For this reason, it is preferable to have longer backup IOLs available, such as a 14.0-mm long three-piece polymethylmethacrylate (PMMA) IOL, or the STAAR Surgical (Monrovia, CA) AQ-2010 foldable three-piece silicone lens with an overall length of 13.5 mm. A single-piece acrylic IOL should never be placed in the sulcus because the overall length is too short and the haptics are not rigid. In addition to poorly centering the lens, the thicker, sharp-edged haptics will rub against the back surface of the iris, causing iris transillumination defects and pigmentary glaucoma.

Although anatomical studies have shown that there is no reliable way to gauge the ciliary sulcus diameter according to external landmarks, it is helpful to measure the white-to-white corneal diameter intraoperatively. If it measures 11.5 mm or less, a standard 13.0-mm long foldable IOL will probably center well in the sulcus. Absent capsulorrhexis capture, a longer IOL should be considered, however, if the sulcus diameter is 12.0 mm or larger. An advanced option is to anchor the sulcus-fixated IOL by suturing one haptic to the iris. A single 10-0 polypropylene McCannel suture around one of the haptics will be enough to keep the lens from rotating or decentering. Finally, a properly sized and well-placed anterior chamber IOL is always an excellent option if posterior chamber IOL support is not ideal.

**Final Comments**

Cautious adherence to these principles described above may help surgeons to reduce the chance of dropping the nucleus following posterior capsular rupture. However, there is a potentially fine line dividing maneuvers that are reasonable and safe from those that are overly aggressive or dangerous. Cataract surgeons must be honest in assessing their own level of comfort and expertise. Timely surgical management of a dropped nucleus by a vitreoretinal surgeon at a later date is always preferable to overstepping this fine line.

**References**