Managing the Dropped Nucleus

Tips on managing this complication during cataract surgery.

By Richard J. Mackool, MD

Cataract surgeons often view a dropped nucleus as a dire complication, whereas experienced vitreoretinal surgeons find the problem to be fairly straightforward. This article shares some steps that anterior segment surgeons can take when the nucleus drops. If the situation is more complicated, however, they should always remember that they can refer the case to a vitreoretinal surgeon.

ADVANCE PLANNING

When a nucleus has dislocated deep into the vitreous cavity, surgeons should perform a thorough anterior vitrectomy and then implant an IOL. If the capsulorhexis is intact and smaller than the optic, it is highly desirable to place a multipiece IOL in the ciliary sulcus and capture the lens' optic in the capsulorhexis because of the stable fixation that this approach provides. The IOL's power should not be adjusted, as it should when placed in the sulcus without capture of the optic, because the effective lens position will essentially be the same as if the lens were entirely within the capsular bag.

If the capsulorhexis is too large for an IOL with a 6-mm optic, surgeons may wish to implant an IOL with a 6.5-mm optic (eg, MA50 or MN50 series [Alcon Laboratories, Inc., Fort Worth, TX]). If the capsulorhexis is not intact but capsular support seems to be adequate, placing a PCIOL within the sulcus is appropriate. When inserting the IOL, it may be wise to tie a suture to the trailing haptic until the lens is safely located at the desired position. The suture can then be cut as it passes beneath the iris sphincter. Of course, should capsular support be inadequate for PCIOL insertion, the surgeon may either suture the PCIOL or place an ACIOL.

PREVENTION

At the first sign of an open posterior capsule, I recommend injecting an ophthalmic viscosurgical device (OVD) behind any remaining nucleus. Doing so can be difficult, depending on the location of the lenticular material, if the OVD cannula is inserted through the limbus. The injection, however, is entirely straightforward if the pars plana route is employed as follows.

I attach a sharp, disposable 30-gauge needle to the syringe containing the OVD; I strongly prefer Viscoat (Alcon Laboratories, Inc.), because its dispersive nature causes it to resist aspiration during the remainder of the procedure. Next, I insert the needle through the pars plana at a distance of 3.5 mm posterior to the limbus. I inject a generous amount of the OVD immediately posterior to the nucleus, and it may be necessary to simultaneously release fluid from the anterior chamber to avoid overinflation of the globe. I then inject an OVD through the limbus and anterior to the nucleus. Phacoemulsification can then be continued under relatively low flow and vacuum settings to complete nuclear removal.

POSTVITRECTOMY MANAGEMENT

Because the eye may have more inflammation and a greater risk of postoperative cystoid macular edema, prophylaxis is appropriate. I recommend treatment with a combination of steroidal and nonsteroidal topical medications as well as a long-acting cycloplegic, because the cycloplegic has an anti-inflammatory effect that is additive to the steroids and nonsteroidals. In my experience, using these three agents together often greatly reduces the incidence and severity of cystoid macular edema after surgery for a dropped nucleus.

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A discussion of contributing factors and how to proceed.

By William J. Fishkind, MD

When considering how to approach a dropped nucleus, it is important to take into account predisposing and intraoperative problems that can lead to nuclear loss as well as strategies for intraoperative and postoperative management.[1]

RISK FACTORS

Predisposing factors that may increase the risk of a dropped nucleus during cataract surgery include:

- Pseudoexfoliation of the lens capsule with zonular weakness visible preoperatively
- Nuclear mature (brunescent) or hypermature cataracts in eyes in which the posterior capsule may be thin and the zonule weak
- Previous trauma in eyes in which the posterior capsule or zonule may be damaged
- Visible zonular weakness or absence preoperatively
- A small eye with a crowded anterior segment, a large eye with a loose capsule that might "trampoline" into the phaco tip, or poor visibility due to corneal scarring or a dense, large arcus senilis
- Previous vitrectomy
- Marfan's syndrome and posterior polar cataracts (although these conditions rarely lead to a lost nucleus)

Intraoperative factors that may increase the risk for a dropped nucleus include:

- Visible tears in the anterior capsule during hydrodissection secondary to nicks in the anterior capsule or anterior capsular block
- Occult tears of the posterior capsule during hydrodissection secondary to anterior capsular block
- The radial progression of an anterior capsular tear
- The equatorial or posterior rupture of the capsule by the phaco tip
- A posterior capsule torn by an instrument or a sharp, mature nuclear fragment during a surge in phaco energy
- A zonular dialysis larger than 3 clock hours

INTRAOPERATIVE MANAGEMENT

Upon recognizing a tear in the posterior capsule, surgeons must make every effort to prevent the nucleus or nuclear fragments from falling into the vitreous. An award-winning video produced by Robert Osher, MD, *Understanding the Dropped Nucleus*,[2] identified the quality and viscosity of the vitreous as the main factor preventing or permitting the nucleus to sink. The nucleus or nuclear fragments will not descend into the vitreous if it is intact, without substantial synereisis. If the vitreous is liquid, however, the nucleus will sink quickly. Surgeons should therefore stabilize the nucleus with a hook and then an ophthalmic viscosurgical device (OVD) while formulating a plan for recovery. If the nucleus is large and mature, conversion to an extracapsular cataract extraction is justified. If the nucleus is large but not mature or there are small fragments, phacoemulsification in the anterior chamber, with the nucleus isolated by a dispersive OVD above and below, may be successful.[3]

Alternatively, a Sheets glide pseudoposterior capsular technique could be utilized.[4] The surgeon trims the glide and places it through an enlarged incision, under the nucleus or fragments. Phacoemulsification is performed over the glide.

Finally, if the nucleus partially falls but remains visible in the anterior vitreous, or if it partially falls posteriorly but some remaining zonules keep it from completely plummeting, a combined technique of Viscoat (Alcon Laboratories, Inc., Fort Worth, TX) and posterior assisted levitation may be of assistance.[5] The surgeon creates a pars plana stab incision beneath the hinged nucleus, which permits access by a Viscoat cannula. The nucleus is then levered with the cannula, and OVD, into the anterior chamber where it is trapped.

Despite the surgeon's best efforts, the nucleus may fall into the vitreous, and if the vitreous is liquid, there is nothing to stop its descent to the retina. Once the nucleus disappears, despite an overwhelming desire to retrieve it, the surgeon is required to stop. Attempts to irrigate the nucleus back into the anterior chamber or engage it with the phaco tip are usually unsuccessful, increase the damage to the retina and macula, and thus substantially increase the risk of retinal detachment and cystoid macula edema. Surgeons trained in the technique might consider a three-port posterior vitrectomy. Because few US surgeons are skilled at this procedure, their best line of attack is to perform an anterior vitrectomy, if indicated by visualization of vitreous in the anterior chamber.

ANTERIOR VITRECTOMY

Dilute (4 mg/mL), preservative-free triamcinolone acetonide (Triesence; Alcon Laboratories, Inc.), injected into the anterior chamber, can facilitate visualization. Next, surgeons should remove the residual cortex. If possible, an IOL should be implanted with fixation in the ciliary sulcus while the optic is captured through the anterior capsule. If such fixation is not possible, the surgeon can place the IOL without fixation in the bag and adjust the

lens' power for the more anterior placement in the sulcus. If posterior fixation is not an option, an ACIOL should be considered. Securing the surgical incision to guarantee the wound's integrity for the possible later vitrectomy is important. One or two 10–0 nylon sutures are adequate.

POSTOPERATIVE MANAGEMENT

Patients should receive intense treatment with topical steroids, nonsteroidal anti-inflammatory drugs, and fourth-generation fluoroquinolones, all instilled a minimum of q.i.d.

Debate continues as to how long a nuclear fragment can be left in the vitreous. There are reports of serious uveitis, glaucoma, cystoid macular edema, and even phacolytic glaucoma and phaco anaphylactic uveitis.[6-8] Generally, if the material in the vitreous is cortical in nature or a small nuclear chip, it can be observed and will usually dissolve over time. The development of vitritis necessitates a vitrectomy. A large fragment, or the entire nucleus, must be removed within a week of surgery.[9] An expeditious referral to a retina specialist is thus warranted. At the time of vitrectomy and lensectomy, intravitreal steroids may improve visual outcomes.

CONCLUSION

The intraoperative loss of the nucleus or nuclear fragments is unquestionably inauspicious. Surgeons prepared to manage this complication, however, are capable of avoiding further surgical damage. With the assistance of a retina colleague, an exceptional visual result can be achieved in these cases.

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Preventing vitreoretinal traction is critical to good outcomes.

By Steve Charles, MD

When capsular rupture and posterior dislocation of lenticular material occur, surgeons' primary goal should be to prevent acute vitreoretinal traction; retinal breaks resulting in retinal detachment are largely preventable with proper technique. Charles Kelman, MD, recommended posterior assisted levitation to support the nucleus after capsular rupture,[1] but it is a potentially dangerous technique that displaces the anterior vitreous and causes acute vitreoretinal traction. A phaco probe should never be used to remove lenticular material posterior to a capsular rupture, because ultrasonic energy emulsifies hyaluronan but not collagen fibers. Similarly, both irrigation to "float up" the nucleus and using a lens loop to retrieve lenticular material cause acute, unacceptable vitreoretinal traction.

THE BASICS OF ANTERIOR VITRECTOMY

Because vitreous is virtually invisible, I recommend the use of preservative-free triamcinolone acetate (Triesence; Alcon Laboratories, Inc., Fort Worth, TX) to enhance visualization.

Many surgeons still use cellulose sponges for anterior vitrectomy and to test for vitreous in the anterior chamber, within the wound, or on the iris. Leading vitreoretinal surgeons have universally recommended against this practice for 3 decades, because it causes marked and instantaneous vitreoretinal traction. Traction on the anterior vitreous is particularly dangerous because of its proximity to the strong, permanent vitreoretinal adherence at the peripheral base and because the peripheral retina has approximately 1/100 the tensile strength of the posterior retina. The sponge produces traction by wicking and also when the vitreous is lifted for cutting. Sweeping with a spatula produces vitreoretinal traction, because one end of the collagen fibers is mechanically fixed in the wound while the other end remains adherent to structurally weak retina at the vitreous base. The surgeon should use a vitreous cutter to sever any posterior connection to vitreous in the wound. In some instances, viscoelastic can be used to express vitreous out of the phaco wound into the anterior chamber.

REDUCING VITREORETINAL TRACTION DURING CUTTING

Vitreous cutters section vitreous collagen fibers by shearing as the inner needle moves past a port in the outer nee-

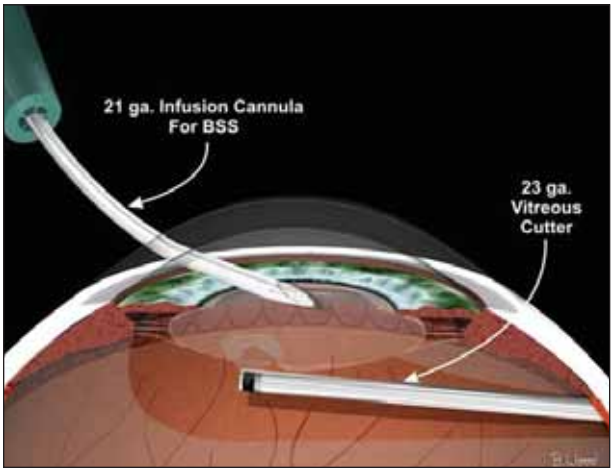

Figure 1. Bimanual anterior vitrectomy with sideport infusion.

dle. High cutting rates (at least 800 cpm) reduce vitreoretinal traction by decreasing the travel of collagen fibers before shearing takes place. The smaller the average cut fiber, the less vitreoretinal traction. Port-based flow limiting created by the cutter's interrupting flow through the port reduces pulse flow, defined as the amount of fluid that moves through the cutter's port with each open-close cycle. Port-based flow limiting is analogous to the anterior chamber stability produced by high-vacuum, low-flow phacoemulsification. The lowest effective suction levels and flow rates are safer, because they produce less vitreoretinal traction from uncut collagen fibers traveling through the cutter. Surgeons should slowly increase the suction or flow rate until the removal of vitreous starts while always using the highest cutting rate available. They should hold the cutter stationary or advance it into the vitreous while applying suction to reduce traction; it is unsafe to withdraw the probe while the foot pedal is in position 3 with vacuum engaged. The cutter's tip should always be in view.

The separation of infusion and the cutter is essential to reduce turbulence as well as the wound's size; an infusion sleeve should never be used. The surgeon should place the cutter through the pars plana or a sideport incision while maintaining infusion through a sideport incision (Figure 1), never through the phaco wound. A pars plana approach causes the vitreous to move posteriorly without sweeping the wound, but surgeons can employ a two-port approach using two sideports if they are not comfortable with a pars plana approach. For a pars plana approach, surgeons should use a microvitreoretinal blade to make the incision. After creating a small fornix-based flap away from the 3- and 9-o'clock positions to avoid ciliary nerves and vessels, surgeons should apply minimal cautery as needed and take caliper measurements for the sclerotomy 3.5 mm posterior to the limbus. The eye should be firmed in advance through the sideport and the microvitreoretinal blade advanced until it can be visualized in the pupil. After completing the vitrectomy, surgeons should close the incision with an 8–0 Biosorb suture (Alcon Laboratories, Inc., Fort Worth, TX), which causes less inflammation than Vicryl (Ethicon, Inc., Somerville, NJ) in the author's experience.

POSTERIOR VITRECTOMY TO REMOVE NUCLEAR MATERIAL

Postponing the posterior vitrectomy and removal of dislocated lenticular material for a few days will allow the cornea to clear, the pupil to dilate fully, and the wound to become more secure. In order to prevent vitreoretinal traction, the surgeon must perform a pars plana vitrectomy before using the fragmenter to remove lenticular material. Temporarily oversewing the wound with 9–0 or 10–0 nylon will prevent leaks and iris prolapse.

Lenticular material will never damage the retina, and the concept of allowing vitreous to support lenticular material during fragmentation is dangerous. Endoillumination, high-speed cutting (2,500 to 5,000 cpm), a fundus contact lens, and significant training on and experience with pars plana vitrectomy are necessary to safely perform these cases. Surgeons should remove all vitreous before lifting the lens material away from the retina with the fragmenter by means of linear suction; linear ultrasound is then engaged by pedal sidekick to emulsify the lenticular material. If the fragmenter needle drills into the nucleus, the surgeon can use the endoilluminator to push off the nucleus—or use it bimanually to crush the nucleus into the port or chop it. Continuous ultrasound and simultaneous continuous aspiration to prevent scleral thermal damage are the best approach. Perfluorodecalin can be used to float a dense nucleus into the anterior chamber after posterior vitrectomy; two vials are usually required.

As a final reminder, the goal in vitrectomy for a dropped nucleus after cataract surgery is to prevent intraoperative as well as postoperative vitreoretinal traction leading to a retinal detachment.

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A case example.

By Mark Packer, MD

A recent case of mine illustrates the principles I employ when managing a dropped nucleus.

CASE PRESENTATION

A pilot presented with a desire to be able to fly without wearing glasses. The patient had a history of a right Bell's palsy and vertical binocular diplopia, and he described some fluctuating vision in his right eye, the acuity of which had never been perfect due to refractive amblyopia.

The patient had a visual acuity of 20/40- OD and 20/20 OS. Table 1 shows his correction with glasses, and Table 2 provides his manifest refraction.

We discussed the options for a refractive lens exchange, given his age, occupation, and desire for spectacle independence at distance and near. I explained that his fluctuating vision was probably owing to the facial palsy and dryness of the ocular surface, which resulted in an irregular tear film due to an incomplete blink. I advised him of the need to optimize his tear film during the perioperative period. Following any refractive procedure, of course, strabismus surgery would be necessary to eliminate his need for prism (he had a fairly comitant left hypertropia).

After reviewing his keratometry readings (3.40 D @ 79 OD, 0.33D @ 91 OS), I discussed with the patient the options of a toric IOL versus limbal relaxing incisions as well as the differences between accommodating and multifocal IOLs. Ultimately, he chose to receive the Crystalens (Bausch & Lomb, Rochester, NY) with limbal relaxing incisions followed by planned strabismus surgery 6 weeks later. He chose to receive a monofocal rather than a multifocal lens if the capsular bag became damaged during surgery and contraindicated the use of an accommodating IOL. We also discussed the option of PRK on his right eye as an enhancement procedure to correct any residual refractive error. He began therapy with Restasis (Allergan, Inc., Irvine, CA) preoperatively.

SURGICAL COURSE

I created a 4.5-mm capsulorhexis, because I have found better refractive predictability with the Crystalens when the diameter of the capsulorhexis is smaller than that of the lens optic. During hydrodissection, I expected the soft nucleus to prolapse anteriorly out of the bag (Figure 1A). Instead, his nucleus was a bit firm, and I pushed a little too hard (Figure 1B). Rather than hydroexpress the lens out of the bag, pressure on the plunger of the syringe of balanced salt solution popped the posterior capsule and caused the lens to fall backward (Figure 1C). My attempt to lever the lens forward from the opposite direction met with disaster, as the entire lens came to rest on the temporal pars plana (Figure 1D).

TABLE 1. PREOPERATIVE CORRECTION

Eye	Sphere	Cylinder	Axis	Add	Prism
Right	-5.50 D	+2.75 D	69°	+2.25 D	1BI/8BU
Left	-1.50 D	+0.75 D	158°	+2.25 D	3BD

TABLE 2. PREOPERATIVE MANIFEST REFRACTION

Eye	Sphere	Cylinder	Axis	Add	Prism	Distance Visual Acuity
Right	-5.50 D	+2.50 D	65°	+2.25 D	8BU/1BI	20/30+
Left	-1.25 D	+0.75 D	170°	+2.25 D	3BD	20/20

TABLE 3. POSTOPERATIVE MANIFEST REFRACTION

Eye	Sphere	Cylinder	Axis	Add	Distance Visual Acuity	Near Visual Acuity
Right	-1.50 D	+2.75 D	85°	+2.00 D	20/20+	J1+
Left	-1.00 D	+1.00 D	175°	+2.00 D	20/20	J1+

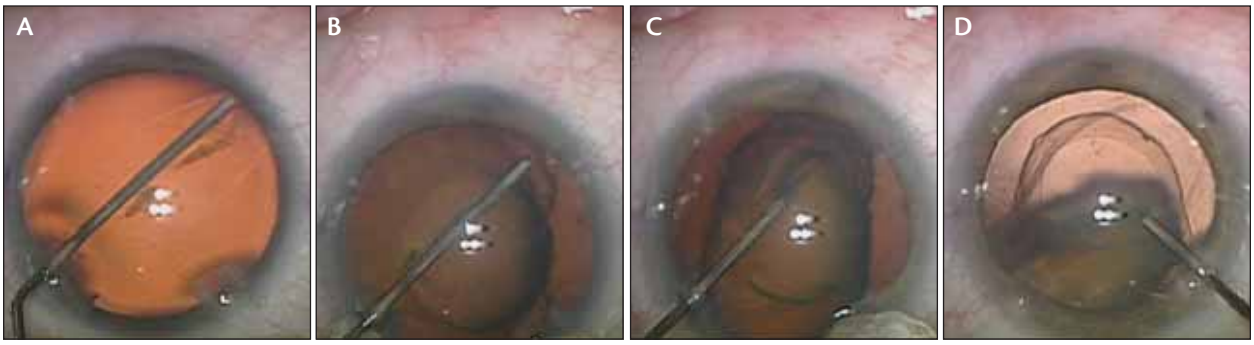

Figure 1. Rather than a soft nucleus (A), the author encountered a firm one that prompted him to push too hard during hydrodissection (B), which caused the posterior capsule to rupture and the lens to fall backward (C). Efforts to lift the lens from the opposite direction left it on the temporal pars plana (D).

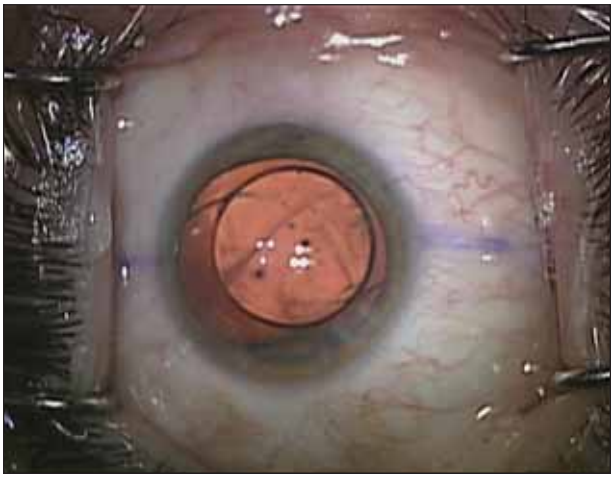

Figure 2. The haptics of this three-piece acrylic IOL are in the sulcus, and the optic has been captured posterior to the capsulorhexis.

I considered resorting to the Kelman posterior assisted levitation technique[1] or the modification described by Richard Packard, FRCS, FRCOphth, in which he uses Viscoat (Alcon Laboratories, Inc., Fort Worth, TX) to raise the nucleus from the pars plana.[1] Instead, I asked OR Manager Cheri van Bebber to get one of the two excellent retina surgeons (Robert Champer, MD, and John Karth, MD) who are partners at the Oregon Eye Surgery Center into the room as soon as possible. Within moments, Dr. Karth was looking through the assistant oculars.

"I could lift that up through a stab in the pars plana," I said.

"I think you'd lift up a bunch of other stuff with it," he said. "Just put in a lens and a single stitch in the incision, and I'll get it out tomorrow."

I placed a three-piece acrylic IOL with the haptics in the sulcus and the optic captured posterior to the capsulorhexis (Figure 2). I did not perform the planned limbal relaxing incisions, because I felt the eye had been through enough for 1 day. After removing the viscoelastic, I irrigated the anterior chamber with triamcinolone (40 mg/mL in a 9:1 dilution in balanced salt solution) in a modification of the technique described by Scott Burk, MD, PhD, to ensure a vitreous-free environment.[2] The patient underwent pars plana vitrectomy/lensectomy the next day, and his recovery was uneventful.

OUTCOME

Six weeks postoperatively, the patient had a visual acuity of 20/50-2 and J10 OD, 20/30+2 and J3 OS, and 20/30+2 and J3 OU. Table 3 shows his manifest refraction.

The remaining challenges include correcting the patient's astigmatism and diplopia. At least his ocular surface has done well! Once I have documented refractive stability, I plan to perform PRK on the patient's right eye. Eventually, a vertical muscle recession/resection procedure with adjustable sutures will provide the final blow for freedom from glasses.

The moral of the story is that, when a dropped nucleus occurs, minimal intervention is often the best option. The surgeon should simply clean up the vitreous, securely place an IOL, and close the wound with a suture. A vitreoretinal consultation can often resolve a dropped nucleus with minimal morbidity and excellent visual outcomes. ■

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