Managing Retained Lens Fragments After Cataract Surgery

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Phacoemulsification with posterior chamber intraocular lens implantation – the gold standard for managing cataracts results usually in rapid rehabilitation from an anatomic and visual standpoint. However a small percentage of patients develop intraoperative or postoperative complications, the commonest being retained nucleus or lens fragments and dislocated posterior chamber lens.

Although exact figures are not available, the incidence of posteriorly displaced lens fragments is probably 0.3%. However considering the large volumes of cataract extractions performed, this number is considerable. The displaced fragment may involve the entire nucleus or only its miniscule fraction.

This article will discuss in detail the options for management by the anterior segment surgeon as soon as posterior capsular rent is recognized, when the surgeon still has time to resort to nuclear retrieval techniques. Once the fragment or the entire nucleus has dislocated into the vitreous cavity, the clinical characteristics, indications for removal, timing of the vitrectomy, and the surgical techniques employed are discussed in detail.

For the anterior segment surgeon who encounters the complication of posteriorly dislocated lens fragment during surgery, retrieval of the lens fragment should be attempted only if the fragment is readily accessible. The technique of posterior assisted levitation (PAL techniques) can be tried to bring the nuclear fragment into the anterior chamber. However this technique may exert vitreous traction leading on to retinal tears, retinal detachment and vitreous haemorrhage.

Adequate anterior vitrectomy should be performed to clear any vitreous present in the wound.

Should an IOL be implanted along with the primary procedure when a nuclear fragment was lost posteriorly?

Most vitrectomy surgeons recommend that if there is sufficient capsular support or if suture fixation techniques are available, the IOL be placed in the posterior chamber and the limbal wound closed in the usual fashion.

Implanting a multiflex open loop design AC IOL into the anterior chamber is a viable option provided there is no corneal endothelial decompensation, compromised angles or loss of iris tissue.

Primary IOL implantation is however not advisable if a large chunk of very hard / black nucleus has dislocated, the best option in this situation is to remove it through the limbal route and perform a secondary IOL implant along with the vitrectomy procedure.

Posterior loss of lens fragments is usually recognized by the cataract surgeon after posterior capsular rupture.

Common Predisposing Factors for Posterior Capsular Rupture

Certain types of cataract may be at a higher risk for developing posterior capsular rent. They are
1) posterior polar cataract (PPC) and the cataract associated with posterior lenticus or lenti globus, (2) post vitrectomy cataract, 3) traumatic cataract, 4) white cataract, and 5) black cataract. Preoperative counseling of patients with these types of cataract should include a thorough discussion about the potential for a posterior capsular rent and its sequelae.

**Early Recognition Of Zonular or Posterior Capsular Rupture**

If a posterior capsular tear is not recognized in time, subsequent intraocular maneuvers required for phacoemulsification (viz. nuclear rotation, sculpting, cracking) and fluctuations in anterior chamber depth will quickly enlarge the size of the tear. The risks of vitreous loss and dropped nucleus increase, longer the rupture goes unrecognized. Early recognition of a posterior capsular tear and prompt prophylactic measures will prevent expansion of the tear size.

Signs of early posterior capsular tear or zonular dehiscence include the following.

- Sudden deepening of the anterior chamber with momentary dilatation of the pupil.
- Sudden transitory appearance of a clear red reflex peripherally.
- Newly apparent inability to rotate a previously mobile nucleus.
- Excessive lateral mobility or displacement of the nucleus and loss of nucleus followability.
- Excessive tipping of one pole of the nucleus.
- Partial descent of the nucleus into the anterior vitreous space.

**Rescuing a Partially Descended Nucleus**

Posterior capsule or zonular rupture should be recognized early enough to avoid a dropped nucleus. Without timely recognition of the capsular rent, the continued phaco maneuvers and forces will expand the initial defect thereby creating a big hiatus to permit the nucleus to drop. A brunescent nucleus may abruptly and rapidly sink through the liquified vitreous without antecedent vitreous loss. However if enough supporting vitreous is present the nucleus will descend only partially, allowing for rescue maneuvers. No attempt should be made to chase and spear the descending nucleus with the phacotip. The posteriorly directed fluid infusion will flush more vitreous out, expanding the rent and propelling the nucleus away. Additionally, vitreous may be snagged into the phacotip, potentially leading to giant retinal tears and detachment. An alternative strategy is to levitate the nucleus into the pupillary plane or anterior chamber for subsequent management either by extraction through a standard ECCE incision (or rarely by careful phacoemulsification over Sheets glide). The nucleus may be rescued by injecting viscoelastic behind the nucleus and manipulating it with a hook using a limbal approach. However, this technique may be inadequate if the capsulorhexis is small and intact, if the pupil is small, if vitreous has already prolapsed around the nucleus or it has subluxated laterally or posteriorly. The “PAL” technique (posterior assisted levitation), first developed by Charles Kelman utilizing a cyclodialysis spatula through a pars plana stab incision to push the nucleus up into the anterior chamber from below, is preferred by many. Richard Packard modified this technique by inserting a Viscoat cannula through a parsplana stab incision located 3.5 mm behind the limbus. Through a combination of injecting Viscoat and maneuvering the cannula tip itself, the nucleus can be elevated through the capsulorhexis and pupil and into the anterior chamber. This minimizes iatrogenic vitreous traction and reduces the chance of touching the retina with a metal spatula tip. If the nucleus fragment has totally disappeared from view the surgeon should not blindly fish for it with the phaco or vitrectomy instruments.

After a thorough anterior vitrectomy and residual lens matter removal (with the vitrector or 1/A instruments) an IOL can be implanted or the patient can be left aphakic (depending upon the size and hardness of the dropped nucleus). If patient has been left aphakic, IOL can be implanted at the conclusion of the second stage three-port vitrectomy and dropped nucleus removal by fragmatome or anterior route. Use of the maximum possible cutting rate, lowest vacuum and flow rates reduces traction on the retina. The vitrectomy cutter should be advanced or held stationary during anterior vitrectomy and never pulled away while cutting.
Testing for vitreous in anterior chamber can be accomplished by

1. Injecting air into anterior chamber through the side port incision and looking for fragmentation of the bubble. Air, if used instead of infusion fluid prevents vitreous from hydrating and coming forwards. Air helps to delineate the surface of vitreous and keeps it confined by surface tension.

2. Using triamcinolone acetonide (preservative free) to stain the vitreous in the anterior chamber.

**Infusion Options**

1) **Coaxial Infusion Cannula** for vitrectomy is possible by slipping the infusion sleeve over the vitrectomy tip. There are several disadvantages and dangers of using a coaxial infusion cannula for anterior vitrectomy.

   a) **Enlargement of posterior capsular tear:**
      - The force of the infusion is in the same direction as the direction in which the vitrector tip is pointing. This means that the infusion will be directed towards the deep areas of the eye. As the tip approaches the torn posterior capsule, the infusion flow will strike the capsular flaps and force them apart. This extends the capsular tear and enlarges the opening resulting in prolapse of more vitreous.

   b) **Hydrates the Vitreous:** The infusion fluid hydrates the vitreous increasing its volume and causing it to expand. The only direction in which the vitreous is able to expand is towards the anterior chamber through the opening in the posterior capsule.

   c) **Flushing the Vitreous:** The force of the infusion acts like a high-pressure hose flushing out the vitreous from the eye into the anterior chamber.

   All these factors act together to increase the amount of vitreous that needs to be removed. (Fig: 1, 2, 3)

2) **Bimanual Technique with Separate Infusion Line**

   Place the cutter through the PC Rent with the cutting port facing upwards. The strategy is to pull the vitreous from the anterior chamber down to the cutter.

   The coaxial sleeve around the vitrector is removed and replaced by a separate infusion line. The AC maintainer or the irrigation port of the I/A hand piece can be used. The vitrector tip becomes less bulky and is able to pass through a paracentesis wound. This facilitates vitrectomy in a closed chamber away from the main phaco wound. The appropriate strategy for vitrectomy following vitreous loss during cataract surgery is to use the bimanual technique.

   The vitrectomy tip is inserted through the opening in the posterior capsule and placed a mm or two behind the posterior capsule. The aspiration port is directed upwards towards the cornea. (Fig: 4 & 5)

   ![Fig. 4 & 5. Technique of Performing Anterior Vitrectomy](image)

   The strategy is to pull the vitreous in the anterior chamber down to the vitrectomy tip until no more vitreous is there in the anterior chamber. The offending vitreous in the anterior chamber should be removed down to the level of and just below the posterior capsule. The rest of the vitreous in the vitreous cavity should not be touched. (Fig: 5). It is advisable to begin the vitrectomy dry and then infuse BSS gently, if the chamber tends to collapse, through the side port. More vitreous will prolapse if the pressure in the anterior chamber is low when the aspiration continues.

   The vitrectomy tip should not be placed through the primary phaco incision because the incision is the wrong size for it. Instead the eye should be made firm with...
viscoelastics and a new 1 mm incision be made a few millimeters away from the main phaco incision. The incision is the right size for the vitrector and the original side port incision, the correct size for the chamber maintainer. The pressure in the anterior chamber from the viscoelastics or chamber maintainer irrigation will close off the self sealing corneal or corneoscleral incision previously used for phacoemulsification.

Another portal of entry for the vitrectomy instrument is the pars plana through a sclerotomy 3 mm behind limbus. Infusion is performed using the AC maintainer. The vitrector is used to cut the vitreous at and behind the posterior capsule taking care to retain as much of the posterior capsule as possible.

**Performing Vitrectomy Without Irrigation (DRY Vitrectomy)**

This is a useful technique in performing a small vitrectomy. If the eye softens the pressure in the eye can be equalized by putting more viscoelastic into the anterior chamber. This has the added advantage of pushing vitreous towards the back of the eye and reducing the amount of vitrectomy that has to be performed.

When irrigation is used, the irrigating fluid might hydrate the vitreous in the anterior chamber, but this is acceptable because the vitreous in the anterior chamber is going to be removed anyway. We do not want the fluid to hydrate much of the vitreous below the vitrectomy tip. This is avoided by keeping the infusion cannula parallel to the iris so that the infusion is directed towards the AC and the vitrectomy tip can remove the fluid before it escapes into the body of the vitreous. The force of the infusion can act as a high power hose flushing out the vitreous from the eye. All this movement causes the vitreous to be flushed out of the back of the eye into the AC. This increases the amount of vitreous that needs to be removed. This is what happens when what looks like a small amount of vitrectomy turns into a large one. This is therefore not surprising that vitrectomy following vitreous loss in cataract surgery has a postoperative complication rate of 30 % to 50 %.

The best strategy when performing a vitrectomy is to avoid violating more vitreous than is actually needed. If you can remove the vitreous from the AC, without disturbing the rest of the vitreous especially that which overlies the vitreous base, you should have very few postoperative problems.

**PRE – PPV ASSESSMENT**

Patients with retained lens fragments present with varying degrees of inflammation depending on the size of the fragment, amount of time elapsed following cataract surgery and extent of intraocular manipulation performed.

Clinical signs may include corneal oedema, glaucoma, uveitis and vitreous opacities causing profound visual loss. Frequently however, signs are mild especially in the immediate postoperative interval.

**Preoperative Evaluation**

- BCVA
- Slitlamp Biomicroscopy (pre and post dialation)
  - Degree of corneal oedema
  - Uveitis
  - Cortex at pupil
  - Asses extent of posterior capsular rupture and integrity of capsular zonular apparatus
- Appplanation Tonometry
- Fundus examination/ B Scan USG
- In patients with severe corneal oedema, uveitis retained lens material at the pupil or associated vitreous haemorrhage percluding visualization into the vitreous cavity, a preoperative B Scan
Ultrasonography is essential. Associated pathologies like retinal detachment, choroidal detachment, vitreous haemorrhage can also be picked up (fig 6 and 7).

- Document all findings and discuss options in detail with patients and attender
- Get informed consent

**Management:** If the crystalline lens or lens fragment dislocation is not associated with other problems, it may not lead to any complications on follow-up in a few cases. The eye can be rehabilitated by contact lenses or aphakic glasses. However, in some eyes the dislocated crystalline lens or retained lens matter has to be removed because of complications.

In general, the indications for removal of a dislocated crystalline lens includes impaired visual acuity, resulting from obstruction of the visual axis by the dislocated lens, development of complications such as phacolytic uveitis, or glaucoma, retinal detachment, and vitreous herniation into the anterior chamber resulting in a cystoid macular oedema. A relative indication for surgery is severe monocular diplopia.

Indications for removal of lens fragments:

1. Eyes with small retained lens fragments may be observed without treatment. Careful observation for 1-2 weeks may be safely pursued, especially with smaller fragments and can be extended beyond this depending on clinical progress.

2. Surgery is indicated in eyes with moderate or severe inflammation or retention of 25% or more of lens material.

3. Another indication for prompt surgery is elevated IOP. Medical measures can result in adequate IOP control. If IOP remains uncontrolled despite adequate medical therapy, surgical treatment should be considered.

4. Associated retinal detachments, retinal tears or endophthalmitis are all urgent indications for surgery.

Numerous surgical techniques have been described for the management of dropped nucleus, however, most have been abandoned because of their limitations, complications and complexities. The common techniques currently used to remove a crystalline lens dislocated into the vitreous cavity includes performing a three port pars plana vitrectomy. With this technique a through pars plana vitrectomy with removal of as much of the basal vitreous gel is performed using vitrectomy cutter (Fig. 8). The nucleus is lifted into the midvitreous cavity and fragmented. Frequently it may be necessary to crush the lens between the endoilluminator and the fragmatome into smaller fragments, which can be easily emulsified and aspirated. This procedure, though easy to perform can be hazardous in view of the mechanical retinal damage from falling lens fragments, or due to high energy of...
the ultrasonic probe. There is also an added danger of vitreous traction as the vitreous gets sucked into the probe, if the vitrectomy has not been completed. Retinal damage is particularly likely to occur if these maneuvers are performed when the retina is detached and mobile.

Therefore to remove the dropped nucleus safely and effectively, the use of prefluorocarbon liquids \(^{28,29,30}\) have been recommended. The advantage of using perfluorocarbon liquid in removing dropped nucleus into the vitreous cavity are as follows,

1. The perfluoro carbon liquid lifts the dislocated lens from the retinal surface into the anterior vitreous.

2. In the presence of a retinal detachment, their high specific gravity mechanically flattens out the retina.

3. The PFCL bubble\(^ {31}\) forms a cushion which supports the lens and prevents mechanical retinal damage from falling lens fragments.

Therefore with the use of PFCL \(^ {31}\), the potential for retinal damage is reduced. The surgical technique includes performing a pars plana vitrectomy with removal of as much basal vitreous gel, prior to lens removal (Fig. 8). After the completion of vitrectomy, PFCL is injected into the vitreous cavity over the optic disc floating up the dislocated lens into the anterior vitreous (Fig. 9). If the dislocated lens is associated with a retinal detachment \(^ {29}\), the PFCL injection mechanically flattens the retina against the retinal pigment epithelium, displacing the subretinal fluid through a pre-existing inferior retinal break into the vitreous cavity. The dislocated lens is then fragmented in the anterior vitreous cavity while floating on the PFCL (Fig 10). Small fragments of lens matter that drop, float on the surface of the perfluorocarbon bubble and are easily aspirated. Lens particles can get entangled in the basal vitreous making its removal difficult. Damage to the peripheral retina can occur in an attempt to remove these entangled fragments.

If the dislocated crystalline lens \(^ {32,33,34,35,37}\) is very hard it is preferable to remove it through the anterior (limbal route) using either a cryo or an irrigating vectis (Fig 11).

If the eye with the dislocated crystalline lens also has an associated rhegmatogenous retinal detachment \(^ {31}\), the scleral buckle is placed prior to the lens removal.

Fig. 9. In the presence of retinal detachment the high specific gravity of perfluorocarbon liquid mechanically flattens out the retina.

Fig. 10. The PFCL bubble forms a cushion which supports the lens fragments and prevents mechanical retinal damage from falling lens fragments.

Fig. 11. If the dislocated crystalline lens is very hard it is preferable to remove it through the anterior (limbal) route using either a cryo or an irrigating vectis.

After removal of the lens, endolaser retinopexy is performed around the tear and a PFCL air exchange is carried to achieve pneumohydraulic retinal reattachment.

**Timing of Vitrectomy for removal of retained lens fragment**

Surgery to remove the retained lens fragments is performed within 2 weeks of the original cataract
surgery to expedite visual rehabilitation, to break the cycle of progressive lens induced inflammation, and to avoid long term glaucoma 38.

A higher incidence of glaucoma following vitrectomy 38 for dropped nuclear fragments have been reported in cases where the vitrectomy was delayed for more than 3 weeks 39.

The ideal timing would be to perform the vitrectomy immediately. This is however possible only in larger set ups where the VR facility is readily available.

**Surgical Technique:** There are three basic approaches to removing lens fragments by pars plana vitrectomy 40,41.

1. **By Ultrasonic fragmentation**
2. **Other viable options when a fragmatome is unavailable or when the nuclear material is extremely hard involves (a) crushing the nuclear fragments between the endo illuminator and cutter (b) retrieval through the limbal route.**
3. Using the Vitrectomy cutter for soft nucleus or cortical matter.

Perform adequate vitrectomy prior to use of an ultrasonic fragmatome to avoid vitreous fibrils being sucked into the fragmatome hand piece, causing vitreous traction. Using triamcinolone acetonide to stain the vitreous ensures easy visualization, easy PVD induction and ensures a more complete vitreous removal 42,43.

Reducing fragmentation power to only 5 - 10 % 44,45 facilities nuclear extraction by continuous occlusion of the suction port and avoidance of projectile fragments. This manoeuvre minimizes the risk of projectile fragments falling back to strike the retina causing damage. Using a small bubble of PFCL ensures that there is a cushion between the nuclear fragment and retina enabling safe phacofragmentation and minimizing the risk of projectile fragments. Use of PFCL is also recommended when a retinal detachment is associated with dislocated nuclear fragments. Finally at the conclusion of vitrectomy, the peripheral retina should be examined in detail for possible retinal tears or detachment 35, 36.

A dropped nucleus or dislocated IOL is one of the most serious complications of phacoemulsification. Parsplana vitrectomy in these patients lead to improved vision and is the procedure of choice. Shields showed that 44 % to 71 % of patients achieve a visual acuity of 20/40 or better. Complications associated with vitrectomy includes retinal detachment and cystoid macular oedema 3,42,43.

The incidence of retinal detachment varies from 0 % to 45.4 % (median 15.9 %) and of cystoid vascular oedems from 5 % to 22 % 44,45 (median 20 %). CME can occur several months after cataract surgery and hence adequate follow up is essential. This condition becomes chronic in 20 % eyes. Sulcus placement of a PCIOL 73 at the time of cataract surgery was associated with a lesser incidence (8%) of CME than when the eye was left aphakic (46 %) or when an ACIOL implanted. This could be due to the fact that sulcus placement of the IOL was associated with lesser traumatic cataract surgery, more amount of intact posterior capsule and a reduced iris irritation and inflammation.

Elevated intraocular pressure occurred in 46.3 % 44,45 of cases (25 % to 52 %). A clear association between anterior vitrectomy and decreased incidence of elevated IOP has been validated in various studies.

Review of recent literature 27,33,42 shows that the incidence of retinal detachment before vitrectomy was very low. This may indicate that cataract surgeons have become more experienced in dealing with complications. Resorting to use of lens loop, vectis, forceful irrigation, cryoprobe and phaco inside vitreous cavity are rarely seen in the present day.

Older studies have reported a higher incidence of retinal detachment following vitrectomy to retrieve the lost nuclear fragment (15.9 %). However recent studies show a trend towards a much lower incidence of 5.15 %. Smiddy et al has provided a likely explanation for the lower rates of RD (retinal detachment) after PPV; that is a meticulous examination of fundus periphery with scleral indentation at conclusion of vitrectomy for open iatrogenic breaks and use of ultrasound only when necessary. The proposed association between delayed vitrectomy and retinal detachment has not been validated.

Thus irrespective of its timing, pars plana vitrectomy for dropped nuclei is associated with a good clinical out come as well as a low incidence of complications such as retinal detachment and endophthalmitis.
Conclusion

With the available vitreoretinal microsurgical techniques, successful and safe management of dislocated nucleus or lens fragments is possible. Effective visual rehabilitation in these patients is possible with the availability of better designs and more bio-compatible intraocular lenses.

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