

Combined versus sequential pars plana vitrectomy and phacoemulsification cataract surgery

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ABSTRACT

Cataract development and progression after pars plana vitrectomy (PPV) is nearly universal among older adults. Therefore, the surgical approach to PPV among these patients may include combined cataract surgery and PPV (phacovitrectomy) or lens-sparing PPV followed by sequential cataract surgery once the cataract is visually significant. Both approaches have advantages and disadvantages that should be considered. Combined phacovitrectomy is less costly and reduces the risk of trauma to the crystalline lens or posterior capsule during PPV but can result in poor fundal view during vitrectomy, prolonged visual rehabilitation, and IOL dislocation from intraocular tamponade. Staged/sequential surgery avoids the limitations of a combined approach, but is associated with higher cost and more complex cataract extraction due to anterior chamber instability and possible PPV-related zonular or posterior capsule injury. In this review, we discuss both surgical approaches and share important preoperative and intraoperative considerations derived from our experience and the existing ophthalmic literature.

Keywords: Pars plana vitrectomy, phacoemulsification, cataract, combined sequential staged retroillumination.

INTRODUCTION

Cataract development/progression is one of the most frequent complications of pars plana vitrectomy (PPV).¹ The Vitrectomy for Macular Hole study found that 100% of phakic eyes had cataract progression at 2 years post-PPV. (VMHS). Among a large UK cohort of vitrectomized eyes with an average patient age of 65 years, as many as 50% required cataract surgery 1 year after PPV and 85% by 5 years.² The exact mechanism of cataract formation following PPV is unknown, but increased oxygen tension after PPV inducing oxidative damage to lens proteins has been proposed amongst other theories. Lens touch occurs in approximately 4% of phakic vitrectomies, usually leading to posterior subcapsular cataract (PSC) formation and more rapid cataract progression.³ Posterior capsule violation with lens touch places eyes at higher risk of posterior capsule rupture (PCR) during subsequent cataract surgery.⁴

Certain characteristics modify the risk of cataract progression after PPV. Factors associated with higher risk of cataract progression include older age, complex extended PPV, and use of a tamponade agent, particularly long-acting gas.² Factors protective against development and progression of post-PPV cataracts include young age, preservation of the anterior hyaloid, and a diagnosis of diabetes mellitus. Diabetes was found to be protective independent of age. Diabetes is probably protective because decreased retinal oxygen tension at baseline mitigates oxidative damage to the crystalline lens after PPV as compared to non-diabetic eyes.⁵

Because cataract formation is essentially inevitable following PPV in patients over 55 years of age, two surgical approaches to PPV may be considered – (1) performing combined phacoemulsification cataract surgery and PPV

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(phacovitrectomy) in one setting versus (2) a staged approach consisting of lens-sparing PPV followed by cataract surgery when indicated.⁶ In this review, we discuss both surgical approaches, including their advantages and disadvantages, and important considerations regarding their selection and implementation by the posterior segment surgeon.

Combined Phacoemulsification and PPV

In addition to being more cost effective for the healthcare system and patients, combined phacovitrectomy eliminates the risk of lens touch and, therefore, allows for more complete removal of peripheral vitreous. Combined surgery may also facilitate earlier visual rehabilitation than a staged approach. However, cataract extraction in younger patients with minimal to no cataract results in early loss of accommodative ability. Prolonged surgical time with combined surgery can make vitrectomy more technically challenging if corneal edema or pupil narrowing develops intraoperatively. Postoperative anterior uveitis associated with fibrinous exudate and posterior synechiae formation is also more likely with prolonged surgical time. One large study also found that combined surgery was associated with higher risk of PCR as compared to sequential surgery and this may complicate the flow of the vitrectomy surgery.⁶ Use of gas tamponade during vitrectomy can also precipitate IOL dislocation in the postoperative period. In addition, optical biometry for an eye with macula-off retinal detachment or significant vitreous opacities can be challenging and may require reliance on the fellow eye for intraocular lens (IOL) calculations. Staging cataract surgery to be performed after PPV and resolution of posterior segment pathology may allow same-eye biometry and, consequently, more accurate IOL calculations.

Staged Phacoemulsification and PPV

Staged surgery avoids the limitations of combined phacovitrectomy but adds cost to the patient and healthcare system. Additionally, absence of vitreous support during phacoemulsification in a vitrectomized eye increases surgical complexity due to greater anterior chamber fluctuation. The risk of zonular dialysis is also increased 2-fold in cases of prior lens touch or direct zonular injury at the time of PPV.²

Surgical considerations for combined phacovitrectomy

Preoperative

Before scheduling for surgery, the surgeon must justify combined phacovitrectomy by confirming that the cataract

is relevant to the visual acuity and/or retinal pathology or would hinder the view during PPV. Patient expectations should also be managed with appropriate education. They should be informed that visual rehabilitation following phacovitrectomy is likely to take longer than a standalone cataract surgery.⁷ Once the decision for combined surgery is made, the appropriate selection of IOL type and power is essential. In cases of epiretinal membrane, the A-scan report should be reviewed carefully to ensure the axial length of the eye was measured using the retinal pigment epithelium as reference rather than the epiretinal membrane to avoid a myopic surprise following surgery. Additionally, if there is a macula-off or large retinal detachment, optical biometry of the fellow eye should be used for IOL power calculations. Optically advanced IOLs (i.e. multifocal IOLs) are best avoided with phacovitrectomy. The Placido disc pattern of the multifocal surface can interfere with fundus visualization during vitrectomy. As light passes through the different optical zones of the IOL, areas of interest can abruptly become optically distorted or seem to disappear and reappear in a different place.⁸ Additionally, the quality of vision would particularly diminish through a multifocal lens should IOL tilt or decentration occur.^{9,10} Hydrophilic IOLs are also at higher risk of decentration in vitrectomized eyes as compared to hydrophobic IOLs and, therefore, are best avoided.⁹ We prefer hydrophobic acrylic IOLs to silicone IOLs for multiple reasons. Silicone lenses interfere with the fundus view during PPV, are associated with higher rates of posterior capsule opacification (PCO), and droplets of residual infusion fluid is more likely to remain adherent to the posterior surface of the IOL after fluid air exchange if the posterior capsule is open. Additionally, if silicone oil is used, the risk of oil droplets adhering to the IOL and compromising fundus visualization is several times higher than with acrylic IOLs.

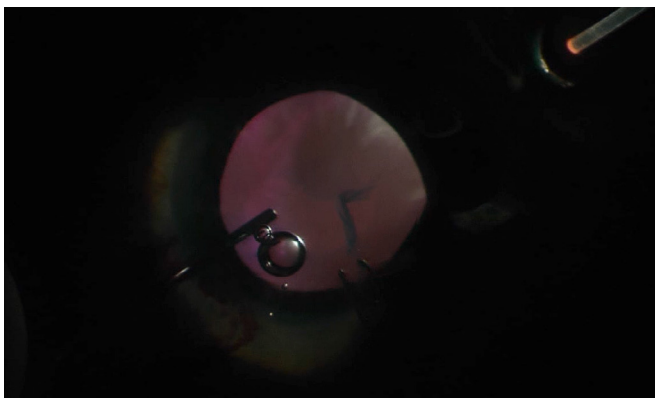
Intraoperative

Vitrectomy trocars are best placed before making the corneal wounds for phacoemulsification. Trocar insertion is more challenging after cataract extraction because the globe is softer and applied pressure to the sclera can cause the corneal wounds to leak, even when sutured. We also prefer to make a smaller capsulorrhexis, about 5 mm, especially when gas or silicone oil tamponade is used, to ensure the IOL optic is well secured with good anterior capsule overlap and less likely to decenter. After cataract removal, we generally opt to implant the IOL before proceeding with PPV, preferably with an acrylic IOL and anterior haptic angulation. We routinely aspirate any

ophthalmic viscoelastic device (OVD) from the anterior chamber (AC) before proceeding with PPV. However, if miosis occurs during the cataract surgery, we recommend leaving OVD in the AC until after PPV is complete to reduce further miosis and compromise of the fundus view. Intracameral injection of epinephrine 0.025%/lidocaine 0.75% (epi-Shugarcaine) can be a helpful adjunct to enlarge the pupil. When removing OVD after PPV, it is essential to perform this step with posterior segment infusion turned off and the vitreous cavity filled with balanced salt solution or perfluorocarbon liquid before the insertion of any air, gas or silicone oil to avoid AC collapse from posterior back pressure. Corneal wound hydration is best delayed until after PPV so that the retinal view is not diminished by corneal edema. Well-constructed corneal wounds should not leak with pars plana infusion, but interrupted 10-0 nylon or vicryl sutures can be placed if the wound is short or the AC continues to shallow during PPV. Finally, if the vitreous cavity is filled with air or gas, we prefer to place an air bubble in the AC to decrease the chance for decentration with adequate counter pressure on the IOL.

Retroillumination-assisted cataract surgery

In phacovitrectomy cases in which the red reflex is absent or severely blunted such as in cases of dense vitreous hemorrhage, a retroillumination technique with either a chandelier or light pipe can be employed to improve visualization during cataract extraction. Use of a chandelier is particularly advantageous as it provides adequate visualization of lens structures while freeing both hands to perform bimanual surgery, but cost can be a limiting factor to its use.¹¹ A light pipe adds less cost to the surgery, but it can only be used in steps that do not require bimanual dexterity, which include the capsulorhexis and cortex removal.¹²



Chandelier retroillumination is used to aid in visualizing the anterior capsule in this case of phaco-PPV with dense vitreous hemorrhage

Surgical considerations for post-PPV cataract surgery

Preoperative

Before deciding to perform cataract surgery on a vitrectomized eye, careful evaluation must be done to ensure the patient's decreased vision is at least in part due to cataract progression. Evidence of zonular dialysis, including lens subluxation and phacodonesis, and occult posterior capsule injury, including linear marks on the posterior lens surface or fibrotic subcapsular patches, are critical to identify for preoperative planning. Rapid progression of a PSC with persistent anterior chamber reaction after vitrectomy should also alert the surgeon to the possibility of posterior capsule violation. It is also important to determine if any other surgical procedures need to be performed at the time of cataract extraction for coexisting retinal pathologies, such as epiretinal membrane peel or silicone oil removal. Intravitreal steroids can be administered preoperatively or intraoperatively for patients with coexisting cystoid macular edema (CME).

Intraoperative

In any case with suspected posterior capsule injury, anticipation of PCR with dropped lens fragments is warranted. The case should ideally be performed by a posterior segment surgeon comfortable with cataract surgery or by an anterior segment surgeon in collaboration with a posterior segment surgeon.

Vitrectomized eyes commonly have deep anterior chambers due to absence of vitreous support, making it more difficult to reach the lens-capsular bag complex.¹³ Since the instruments will need to be angled slightly more vertical to compensate for the exaggerated AC depth, creating an appropriately sized corneal wound is particularly important. The incision should not be made too long in order to avoid pressing against the walls of the wound and forming excessive corneal striae that disrupts the view. Fluctuation in anterior depth due to excessive movement of the lens-iris diaphragm is also typical in a vitrectomized eye. Maintaining a stable AC will reduce the risk of associated complications, including intraoperative aqueous misdirection and pupillary miosis.¹³ Gentle maneuvering of surgical instruments within the eye, controlled insertion and removal of instruments through the corneal incisions, and hydration of wounds prior to final OVD aspiration will help avoid AC collapse.

Post-PPV cataract surgery is associated with higher rates of zonular dialysis.² Occult zonular dialysis can be missed

on pre-operative examination. Intraoperative signs that should alert the surgeon to weakened zonular support include difficulty initiating a capsulorrhexis flap with backward movement of the lens or rocking of the lens during capsulorrhexis progression. If there is significant zonular loss, placement of a capsular tension ring or segment should be considered prior to IOL insertion.

Hydrodissection should be avoided in cases of confirmed or suspected lens touch, as the generated fluid wave can easily induce a PCR if there is a posterior capsule defect. Hydrodelineation with viscodissection of epinucleus from lens cortex is a much safer approach. Nucleus removal should follow with a non-rotational technique to further avoid disruption of the posterior capsule. Finally, if an intravitreal injection is planned during surgery, such as for concomitant CME, it is best performed before final OVD aspiration when hypotony is unlikely and the risk of inadvertent retinal injury minimized.

Cataract surgery in a silicone oil-filled eye

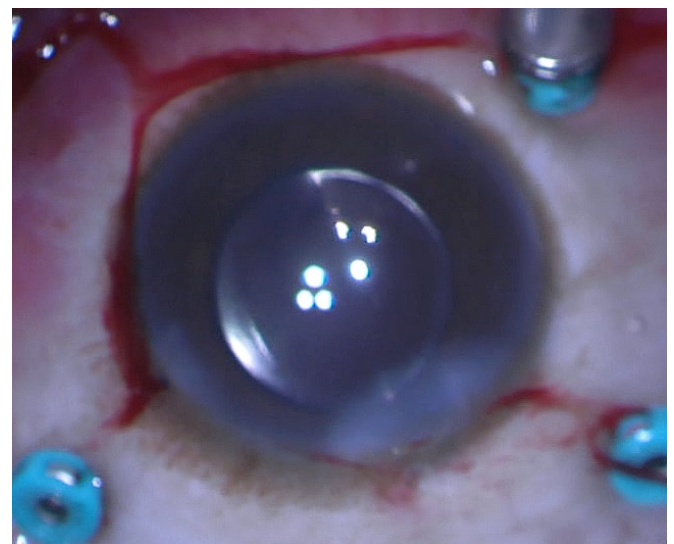
When the vitreous is filled with silicone oil, we prefer to remove the cataract before the silicone oil. Similar to combined phacovitrectomy, we start the case with insertion of all trocars. If there is emulsified silicone oil in the AC, we will wash it out via irrigation/aspiration or exchange with OVD depending on the step of surgery it is identified. Once the cataract is extracted, we perform a posterior capsulorrhexis to access the vitreous cavity. We then guide a silicone oil extractor with a 20-gauge cannula through the posterior capsulorrhexis via the main corneal wound and proceed with evacuating the silicone oil. We find this technique to be efficient and less traumatic to the eye, as it avoids the need for a 23- or 20-gauge sclerotomy to extract the silicone oil. Once all the silicone oil is removed, we examine the retina with endoillumination for any retinal tears or other pathology that requires an additional surgical step, such as endolaser retinopexy or membrane peel. We then finish the case with implantation of a one-piece acrylic IOL in the capsular bag.

CONCLUSION

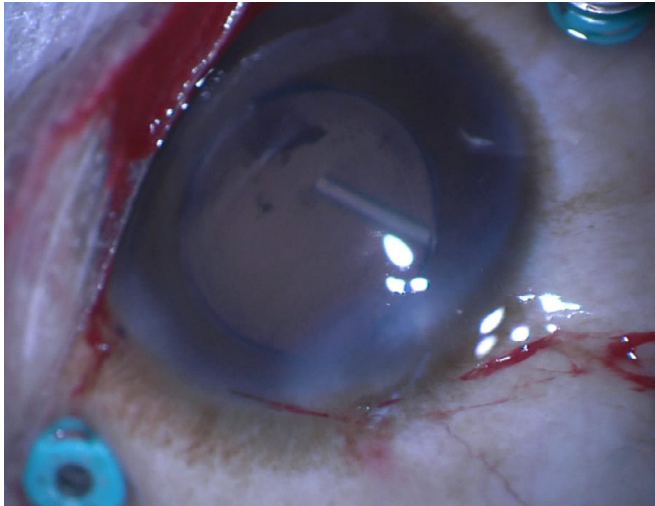
Combined and sequential cataract surgery and PPV both have unique advantages and disadvantages. Combined surgery is more cost effective and avoids the risk of lens touch, but it may be associated with a higher risk of PCR and can potentially make vitrectomy more challenging due to complications related to prolonged surgical time, such as intraoperative corneal edema and pupil narrowing.

Also, the risk of IOL lens decentration could be higher if intraocular tamponade is used. A staged approach is more costly and cataract extraction in a vitrectomized eye is more technically challenging, especially if there is concern for lens touch or zonular instability/dialysis as a consequence of vitrectomy. However, the fundus view is less likely to be compromised during the initial vitrectomy, it spares the patient early loss of accommodative ability, has less risk of IOL decentration, and there is less reliance on fellow eye biometry.

In our practice, we prefer to simplify our approach to PPV. We tend to perform combined phacovitrectomy only if the fundus view is significantly compromised by crystalline lens opacification. We will also perform combined surgery if there is vitreous hemorrhage with significant retrocapsular dusting of the anterior hyaloid or anterior proliferative vitreoretinopathy requiring anterior access and dissection. These two scenarios are particularly difficult to perform without causing inadvertent crystalline lens trauma or posterior capsule injury, so lens extraction prior to PPV facilitates a much safer surgery. We try to avoid combined surgery for cases where intraocular gas tamponade use is anticipated such as retinal detachment and macular hole due to risk of IOL decentration.



A. View at the end of cataract surgery. Notice the trocars were inserted before the cataract surgery was carried out. There is a blunted red reflex because of dusting of the posterior capsule with hemorrhage



B. Pars plana anterior vitrectomy is used to removed the hemorrhage in the anterior hyaloid with the port of the vitrector facing down or sideways to avoid injuring the posterior capsule.

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