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- **Should Combined Phacoemulsification and Pars Plana Vitrectomy Be Used Routinely?**
By Som Prasad, MS, FRCSEd, FRCOphth, FACS
- **New Technology for Combined Phaco and Vitrectomy**
By Roberto Bellucci, MD

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Should Combined Phacoemulsification and Pars Plana Vitrectomy Be Used Routinely?

A review of the literature.

BY SOM PRASAD, MS, FRCSEd, FRCOPHTH, FACS



Cataracts are a known sequela of vitreoretinal surgery, with an incidence that varies widely but has been reported to be up to 100%.¹ Factors such as age, comorbidity, and vitreoretinal surgical indication increase the rate of cataract formation or progression post-surgery, although the pathology and etiology underlying this have yet to be fully elucidated.¹

Historically, opaque lenses were removed during vitreoretinal surgery to maximize visualization for the surgeon, and in patients with diabetes clear lenses were also frequently removed.^{2,3} However, as vitrectomy was increasingly used for the treatment of macular pucker in the late 1970s, the effect of vitreoretinal surgery on cataract progression was noted.⁴ From the late 1980s, combinations of pars plana vitrectomy with lensectomy, and later extracapsular cataract extraction, were used. Since then, advances in cataract surgery and vitrectomy techniques, including phacoemulsification and sutureless pars plana vitrectomy, have been adopted, contributing to the evolution of combined surgery.^{3,5,6}

When appropriate, combined surgery may offer a number of benefits compared with sequential surgery. The development of cataracts after surgery is circumvented, so it avoids the inconvenience, stress, and risks to the patient of additional surgery, and affords the surgeon improved access to the vitreous base without risk of damaging the crystalline lens. The additional health care resource that sequential surgery would require is also saved.

This review article discusses and evaluates the risk of cataract formation and progression following vitreoretinal surgery, and explores the impact this risk may have on a surgeon's decision as to whether to replace the existing lens with an intraocular lens (IOL) at the same time as vitreoretinal surgery.

RISK AND FORMATION OF CATARACTS

There are three main types of cataract: nuclear sclerotic, cortical, and posterior subcapsular.⁷ A nuclear sclerotic



Figure 1. Thick adherent posterior capsular plaque in an eye in which silicone oil has been used previously.

cataract normally progresses slowly over several years, with hardening and yellowing of the lens nucleus. Cortical cataract etiology involves spoke-like opacity developing in the lens cortex, which affects vision only when the visual axis or entire cortex are involved. Posterior subcapsular cataract has granular opacities occurring just beneath the posterior capsule; they can affect younger people and are associated with glare around lights and reduced near vision.⁷

The most important risk factors for cataract development are age and heredity.⁸ In the developed world, cataracts are rare before 50 years of age, but affect over one-third of people by 75 years of age,^{9,10} with women being at slightly greater risk.⁷ Studies in twins and siblings indicate that genetic effects may account for almost half of the variation seen in nuclear cataract severity¹¹ and approximately 60% of variability in cortical cataract measures (45% in men and 75% in women).^{12,13}

The association between cataract development and

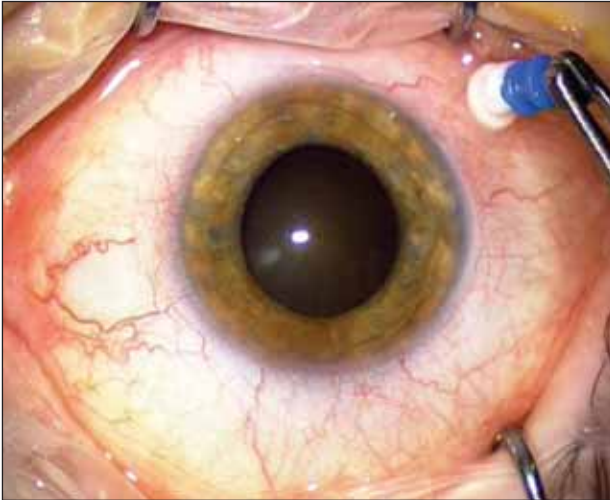


Figure 2. A pars plana port is inserted and closed with a plug prior to commencing the phacoemulsification stage of the procedure.

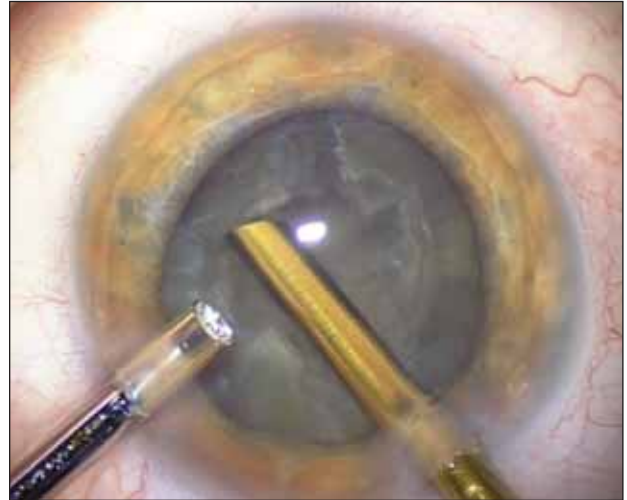


Figure 3. Routine phacoemulsification is carried out by microincision technique, either as a biaxial microincision procedure (as shown here) or a coaxial microincision procedure.

diabetes has been well established.¹⁴ Cataracts are twice as common in people with diabetes older than the age of 65, and up to four times more frequent in those younger than this age, compared with people without diabetes.¹⁴⁻¹⁶ In large population studies, cortical and posterior subcapsular cataracts have been strongly associated with diabetes and poor blood sugar control.^{7,17-20} Obesity has also been linked with risk of cataractogenesis, but the strength of the association has varied widely, and the type of cataract has also been inconsistent, with cortical and posterior subcapsular cataracts most commonly associated.²¹

Strong evidence has been found of an increased risk of nuclear cataract with smoking, with incidence rates three-fold greater among smokers.^{22,23} Evidence of alcohol intake influencing cataract development is conflicting,⁸ with some data suggesting that moderate drinking may have a protective effect, while heavier drinking increases cataract risk.²⁴

Exposure to ultraviolet light from the sun is related to cortical cataracts in the majority of epidemiological and ecological studies, accounting for a 10% population risk.^{8,25-27} The lens is extremely sensitive to ionizing radiation, and studies have suggested that radiologists, those living near Chernobyl, and aviation crews are all at significantly increased risk of cataract, with recent evidence that the damaging threshold is much lower than previously thought.^{28,29}

Intraocular surgery, ocular trauma, and chronic inflammation are all recognized as factors that can cause cataractogenesis.¹ Several other risk factors have been investigated with inconsistent results, including use of steroids and other medications, hypertension, dehydration, malnutrition, and dietary antioxidants.

The role of these and other risk factors will require further clarification.^{7,8,22}

POST-SURGERY CATARACT FORMATION

It has been recognized for many years that vitrectomy causes progression of nuclear sclerotic cataracts,^{1,30} but the underlying etiology of this remains uncertain.⁴ Several factors related to the surgical procedure itself have been suggested to be responsible. These include light toxicity from the operating microscope, the composition and temperature of the vitrectomy irrigating solution, and oxidative damage to lens proteins from exposure to increased levels of oxygen during surgery (and for as long as the oxygen tension remains raised within the eye).^{1,4,31-33} The partial pressure of oxygen is normally low in the lens, and it is well established that oxidative damage of lens nucleus proteins causes opacification.^{31,32} However, duration of surgery may not be associated with cataract risk.³⁴

The use of intraocular gas or silicone oil also accelerates nuclear sclerotic cataract progression, and in addition may increase posterior subcapsular cataract incidence.^{4,35-42} Histopathological investigations indicate that silicone oil may lead to metaplasia or fibrous pseudometaplasia of the lens epithelium.^{35,37,43}

Many sources cite the frequency of cataract as being up to 80% within 2 years of vitrectomy.^{44,45} However, the reported incidence of cataract following vitrectomy varies widely in the literature from 6% to 100%, depending on many factors including the type of patient, vitrectomy indication, duration of follow-up, and the cataract grading system employed. Most published studies are retrospective case reports, and well-designed prospective studies in

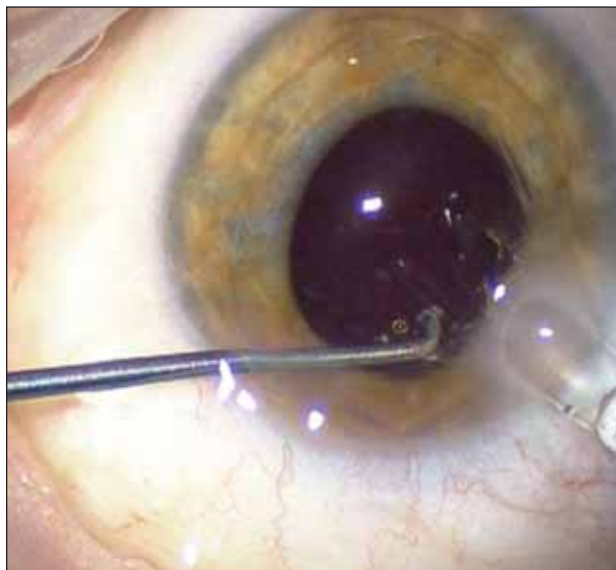


Figure 4. Wound assisted implantation allows IOL implantation through a 1.8 mm incision.

post-vitrectomy cataract progression are lacking.¹

Age at vitrectomy has a striking bearing on the risk of cataract progression^{2,4,42,46}; patients aged older than 50 years have a six- to tenfold greater risk of developing cataracts than those under 50.^{4,46} Melberg et al found that, for a mean follow-up of 25.4 months, only 7% of patients less than 50 years old developed significant cataract progression. This compares with 79% of patients aged older than 50 years in an average post-vitrectomy follow-up of 27.3 months. Patients with diabetes usually have more lens opacity than other patients of the same age, and also go on to develop earlier post-vitrectomy opacities where intraocular gas is used as a tamponade.² Of the clear lenses in post-vitrectomy phakic diabetic eyes, 75% develop cataracts within 10 years.⁴⁷

Cataractogenesis or cataract progression levels are high following vitrectomy in both macular hole and macular pucker indications.¹ In the Vitrectomy for Macular Hole study,³⁴ 81% of 74 eyes that underwent vitrectomy for macular hole had cataract progression at 6 months and 100% had progression by 2 years, compared with 18% and 8% at 6 months and 2 years in fellow (control) eyes, respectively. Similarly, in a study of 100 eyes that underwent vitrectomy for idiopathic macular pucker,⁴² 80% of eyes had significant cataract progression or cataract surgery by an average of 29 months follow-up, compared with 24% of fellow eyes. However, a study found a significantly higher rate of post-vitrectomy cataract progression in eyes that had macular holes compared with eyes that had macular pucker or vitreomacular traction syndrome. A 5-year follow-up study of non-vitrectomizing vitreous surgery in idiopathic macular pucker found no increase in

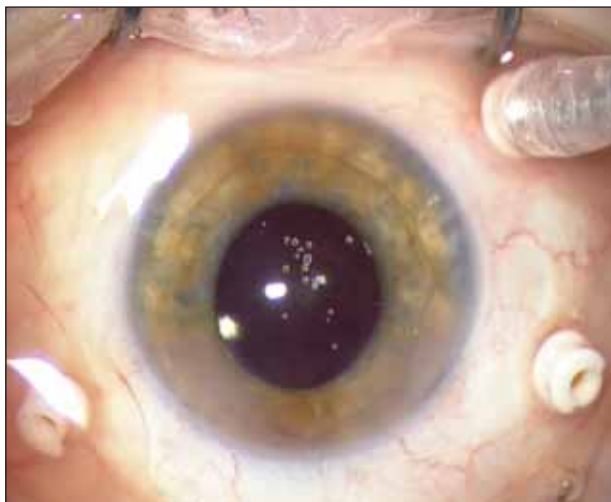


Figure 5. Following completion of phacoemulsification and IOL implantation, the infusion line is placed into the pre-sited pars plana port, and the other two pars plana ports are then inserted.

the risk for nuclear sclerosis with this procedure, but the recurrence of macular pucker appeared higher than with conventional vitrectomy.⁴⁸

In patients with age-related macular degeneration who underwent vitrectomy and surgical removal of subfoveal choroidal neovascularization, 80% of eyes developed post-surgery cataract at 2 years follow-up, while only 39% of eyes with ocular histoplasmosis syndrome that underwent vitrectomy developed cataracts. The difference is likely to be due to the younger age of the latter group.^{1,49,50}

RISKS AND BENEFITS OF VITREORETINAL SURGERY IN TERMS OF CATARACT DEVELOPMENT

Cataract surgery in previously vitrectomized eyes is known to present more surgical challenges and greater risks of complications than in non-vitrectomized eyes,^{33,44,45,51} due to the structural changes that result from the surgery in addition to the underlying vitreoretinal disorder.³³ Cole et al reported a 12.5% rate of intraoperative complications and a 20.8% rate of postoperative complications for cataract extraction in patients with previous vitreoretinal surgery for retinal detachment repair; re-detachment of retinas was seen in 5.6% of eyes.

The loss of vitreous in the vitrectomized eye creates difficulties in generating sufficient support for lens removal during cataract surgery and causes excessive mobility of the posterior capsule and decreased zonular support, with attendant increased risk of capsular tear.⁵²⁻⁵⁴ Additional difficulties in eyes that have previously undergone vitreoretinal surgery include extremely deep fluctuating anterior

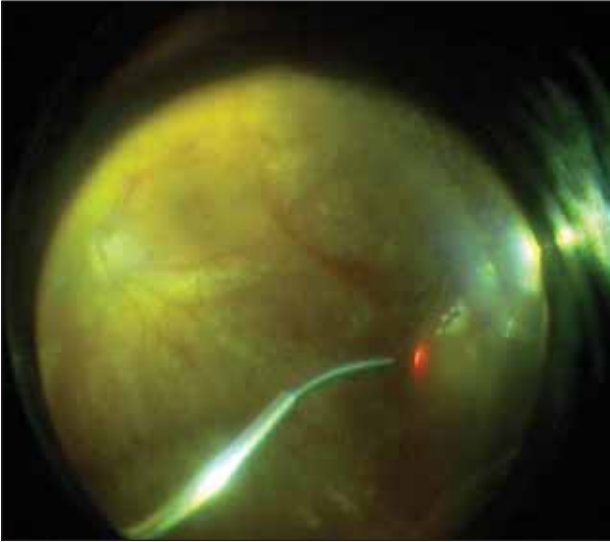


Figure 6. All steps of the pars plana vitrectomy can then proceed; here laser therapy is being applied.

chambers, intraoperative miosis, anterior capsule rigidity, and posterior capsule plaque (Figure 1).^{45,51-59} Furthermore, cataract surgery may also increase progression of diabetic retinopathy, although the evidence for this is unclear.⁶⁰

Due to both the increased risk of cataract development following vitrectomy and the challenges of cataract surgery in the vitrectomized eye, surgery that combines vitrectomy with lens removal may be an appropriate option in many patients. Historically, combination vitrectomy and cataract removal originated from both the need to obtain an adequate view of the retina, which was otherwise obscured by the opaque lens, and the requirement of access to the vitreous base, which may be made more difficult because of the risk of damage to the crystalline lens, during vitreoretinal surgery. The advent of phacoemulsification and IOL implantation has led to the accepted use of this procedure in combination with vitreoretinal surgery.^{3,54,61,62} Phacoemulsification is generally the preferred method of lens extraction as it is associated with less inflammation and discomfort than extracapsular and intracapsular cataract extraction procedures, lower incidence of subconjunctival fibrosis, and it also shortens the time needed for visual rehabilitation.⁶³⁻⁶⁵ In addition, it preserves the posterior capsule so that the IOL can be placed in the capsule bag, facilitating posterior capsule procedures.² More recently the evolution of microincision cataract surgery, with incisions of approximately 1.8 mm, has allowed corneal incisions to remain stable even when deep scleral indentation is deployed. This, combined with the evolution of minimally invasive sutureless pars plana vitrectomy, has allowed combined sutureless phacoemulsification and vitrectomy. This removes the risk of suture-

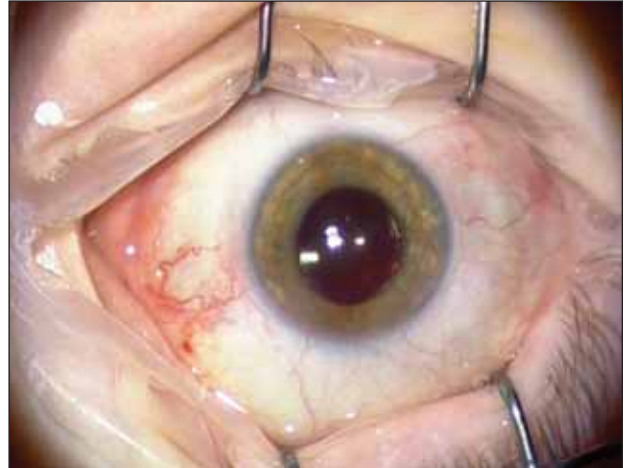


Figure 7. Once the posterior segment procedure is completed, the pars plana ports are removed. Visually, minimal surgical trauma is evident, although fairly extensive intraocular surgery has been performed.

related astigmatism and allows for faster healing and more comfortable eyes in the immediate postoperative period.^{61,66-68}

The sequence of steps in combined surgery is shown in Figures 2 to 7.

Combined surgery has been shown to be safe and effective in patients with diabetes, macular holes and macular pucker, and to allow visual rehabilitation sooner than with consecutive procedures, both in early studies,^{5,6,69-73} and more recently in studies employing phacoemulsification.^{54,64-66,74-81} Studies of retrospective case series comparing combined surgery with sequential surgery have found clinical outcomes to be similar between these two groups.^{54,76,77} The combined phacoemulsification-vitrectomy procedure also appears to be acceptable in eyes with chronic uveitis and in proliferative diabetic retinopathy.⁸²⁻⁸⁷

In order to benefit from combined surgery, it is paramount that appropriate patients are selected. Good candidates for combined surgery are those patients with cataracts that already affect their vision and preclude visualization for the surgeon. Patients who are likely to have cataract progression within 2 years of surgery, such as those aged older than 50 years, are also good candidates, whereas younger patients and those with active rubeosis, severe traction, ischemia or rhegmatogenous retinal detachment are not considered viable candidates.^{2,3}

Combined surgery provides a number of advantages for surgeon and patient, most notably the ability to treat both current and predicted visually significant pathology in a single operation. This allows faster visual rehabilitation, and avoids repeated episodes of vision loss and

vision recovery, as well as repeated exposure to anaesthesia and surgical risk.^{2,54} From the patients' point of view, a reduced number of surgeries and faster recovery time will translate into decreased stress as well as a quicker return to daily life. Where surgery is performed sequentially, the probable scenario for patients at risk of cataract progression or formation will be a gradual loss of vision due to retinal disease, followed by another gradual loss of vision due to cataract progression, with associated loss in quality of life.⁸⁸ Cost and pressure on medical resources will also be reduced with combined surgery.⁵⁴

The combined method affords a number of important additional surgical benefits. These include retained vitreous support for lens extraction, better access to the vitreous base, more effective gas tamponade, and the elimination of the possibility of damage to the lens during vitreoretinal surgery.^{3,54,66} Sutureless methods may result in decreased inflammation and prevention of suture-related astigmatism.⁶¹ Progression of postvitrectomy cataracts can also impede adequate surveillance of diabetic retinopathy, a problem which can be circumvented with combined surgery.²

Several disadvantages are associated with combined surgery, such as increased operating time and extended technical demands on the surgeon. Collaboration with a cataract surgeon may be necessary where the retinal surgeon does not feel comfortable performing cataract surgery or where the referral system does not allow it. Either way, it is crucial that the cataract surgery is done well and does not adversely affect the vitrectomy.²

Most post-surgical complications of combined surgery are typical of the individual procedures which would otherwise be carried out sequentially.⁸⁹ Complications which may occur intraoperatively and affect the surgeon's progress include miosis during cataract extraction, a reduced or absent red reflex which can make capsulorhexis visualization difficult, and bleeding from the anterior of the eye. Manipulation of the globe during vitreoretinal surgery may lead to cataract wound dehiscence, although this is less of an issue with current microincision phacoemulsification incisions. If the IOL is implanted prior to procedures on the posterior segment, prismatic effects and undesired light reflections may result, however current wide angle viewing systems allow good peripheral visualization, even with an IOL in place.

Other complications which might be encountered include loss of corneal transparency from edema and Descemet's folds, IOL decentration, and gas or silicone oil iris capture in eyes.^{3,54,84}

There are many published reports of the successful use of combined surgery in a number of vitrectomy indications, as noted previously. However, the majority of these are retrospective analyses of case series, and prospective

randomized studies are currently lacking. A recent Cochrane review found that there were no randomized trials evaluating the risk and benefits of cataract surgery following vitrectomy, and concluded that its role in patients with retinal disease was therefore uncertain. The review called for additional studies into the clinical outcomes of cataract extraction, either combined with vitrectomy or post-vitrectomy, to determine whether visual acuity is indeed improved over the longer term.¹ The literature base is insufficient to allow best-practice recommendations to be made, however the very nature of rapidly evolving technology means that the literature base available often reflects the techniques and technologies of a few years ago. Current microincision cataract techniques, combined with implantation of a microincision lens and increasing experience and widening indications for sutureless transconjunctival vitrectomy allow a seamless integration between anterior and posterior segment surgery, and at least intuitively, offer an attractive argument to support combined surgery in the postpresbyopic patient who needs posterior segment surgical intervention. Surgeons should rely on their own judgement of the perceived benefits and risks for the patient in deciding whether and when cataract surgery should be performed, based on their clinical knowledge and experience.

CONCLUSIONS

Following vitrectomy, an increased risk of visually significant cataract within 2 years of the procedure is widely reported, however, performing vitrectomy and cataract surgery in a combined procedure, rather than sequentially, circumvents this risk and is particularly relevant to patients in whom cataracts are more likely to form, particularly those over the age of 50 years.

In addition to removing the risk of cataract formation, combined surgery spares patients the inconvenience, stress, surgical risks, and additional rehabilitation time associated with multiple procedures. For the surgeon, removal of the lens prior to vitrectomy offers superior access to the vitreous base and enables more effective gas tamponade during vitreoretinal surgery, while preventing the possibility of damage to the crystalline lens. Vitreoretinal surgery is known to increase the risk of complications and present greater surgical challenges for subsequent cataract surgery, such as the loss of vitreous support in lens removal. Also, the potential for reduced pressure on medical resources cannot be ignored.

The efficacy and safety of combined surgery has been demonstrated by many published clinical experiences in a range of vitreoretinal surgery indications, including macular hole, macular pucker, and in diabetes patients. Clinical outcomes for sequential and combined surgery are similar, and rehabilitation time is reduced. However, further

specifically designed trials are needed to provide robust evidence of the longer term visual acuity outcomes both in sequential and in combined surgery.

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New Technology for Combined Phaco and Vitrectomy

A state-of-the-art system for maximizing outcomes and efficiency.

BY ROBERTO BELLUCCI, MD



In Europe, many ophthalmic surgeons are trained to perform both anterior and posterior segment procedures. Patients who require cataract surgery often have concomitant retinal conditions, some as simple as vitreous degeneration, to more complex cases of epiretinal membranes, macular holes, and retinal detachment, that could be addressed in the same surgery. Vice versa, many of our patients in whom we perform vitrectomy develop cataracts, requiring a second procedure.

In fact, the incidence of cataract formation and progression after vitrectomy has been shown to be as high as 80% over 2 years, particularly for older patients, and even higher when intraocular gas tamponade is employed.^{1,2} In patients younger than 50 years of age, although the risk of cataract formation is lower (7% vs 79%),² the risk increases in longer term follow-up.³ Further, these post-vitrectomy cataracts tend to be accompanied by zonular weakness, deep and unstable anterior chamber, and posterior capsule plaques and defects, and the overall complication rates in cataract surgery post-vitrectomy are higher—approximately 12.5% intraoperatively and 20.8% postoperatively. The risk of retinal re-detachment is approximately 5.6% and the rates of subluxed IOLs

are higher than in nonvitrectomized eyes.^{4,5}

The obvious solution would be to combine these procedures into one surgery, so why are we not doing this for many of our patients? Some concerns that surgeons may have regarding performing a combined cataract and vitrectomy procedure may include a more unstable anterior chamber during vitrectomy, difficulties with visualization, more postoperative inflammation, inaccuracies in biometric measurements, and IOL subluxation.⁶

In cataract surgery, the benefits of microincisions have long been recognized to include a less invasive procedure and a more stable self-sealing microincision. In the past several years, transconjunctival sutureless vitrectomy has become widespread, offering benefits similar to what is seen with microincision cataract surgery. But what about the concerns with chamber stability, visualization, and fluidics?

Cataract surgeons have had the Stellaris (Bausch + Lomb, Aliso Viejo, CA) advanced phaco platform available to them for several years. Recently, however, Bausch + Lomb launched the Stellaris PC, a fully combined phaco and vitrectomy system which addresses many of the issues that have made surgeons hesitant to adopt combined surgery into practice.

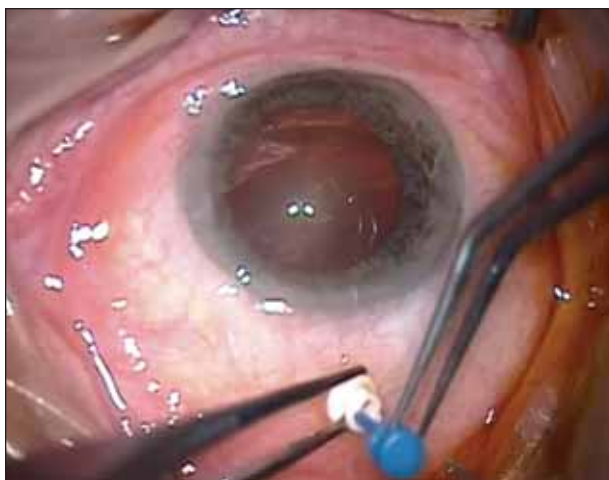


Figure 1. A one-step solid trocar is inserted at the beginning of a combined case.



Figure 2. Phaco through 1.8-mm incision on a brunescient cataract.

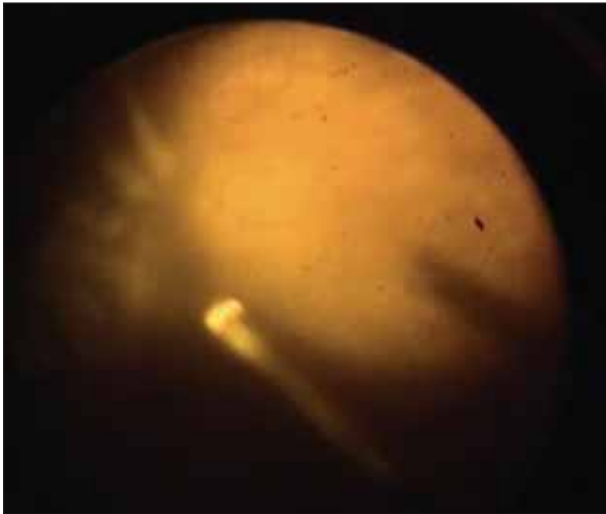


Figure 3. The amber filter is used to reduce the glare from triamcinolone acetonide.

STELLARIS PC FEATURES

The vitrector on the Stellaris PC operates at up to 5000 cuts per minute (cpm) and has a visual and tactile port location indicator. The over-molded rubber grip on the cutter is ergonomic and designed so that the gauge that is being used is easily identified. Further, an extension handle is available for surgeons who prefer a longer handpiece.

The high speed of the vitrectomy cutter translates to less traction on the retina, and the new design of the port brings the cutter opening closer to the distal end, which allows the surgeon to move closer to the retina while maintaining a safe procedure. The 23- and 25-gauge cutters are as efficient as the 20-gauge cutter at their highest speeds.

The new, redesigned Venturi pump responds promptly to surgeon commands via a wireless multi-function footpedal, improving the transition to posterior segment surgery. Additionally, the disposable packs for the Stellaris PC are specifically designed for combined procedures.

The disappointment of discovering lens clouding during posterior segment surgery is no longer present, and we do not have to change or reorganize our machine.

The line of instrumentation for 23- and 25-gauge surgery includes disposable forceps that grasp membranes with strength and precision, and excellent small-gauge scissors. These disposables also allow easier entry with trocars and provide an overall smoother surgery.

The Stellaris PC has both xenon- and mercury-lamp types that are independent and designed to eliminate phototoxic wavelengths. The surgeon can choose between four color filters allow depending on his or her needs.

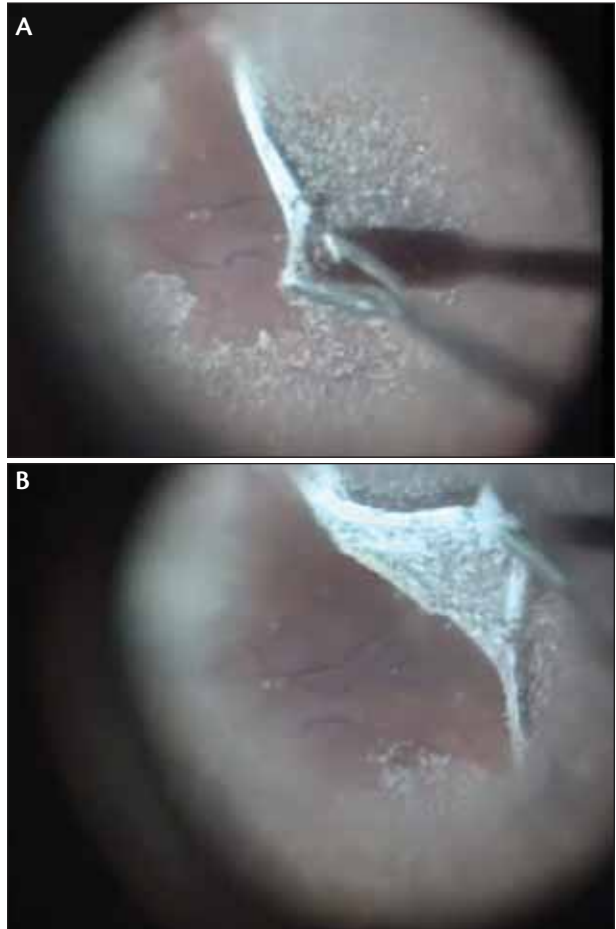


Figure 4. The ERM is lifted with 23-gauge disposable forceps(A) and gently removed (B).



Figure 5. Silicone oil is put into the posterior chamber as tamponade for a macular hole case.

MY COMBINED PROCEDURE

In the first combined case that I performed with the Stellaris PC (Figure 1), the patient had a dense cataract (Figure 2) and an epiretinal membrane (ERM). The Venturi pump was particularly helpful for this scenario

because the fluidics kept the chamber stable. The phaco procedure was smooth and I only had to raise the bottle to 60 cm and use 10% maximum ultrasound power. After implanting the IOL through the 1.8-mm incision, I made an easy transition to the posterior segment. I stained the membrane with triamcinolone acetate and used an amber color filter to minimize the white color of the drug and to see the central vitreous on removal (Figure 3).

I removed the ERM with the new Bausch + Lomb 23-gauge disposable forceps (Figure 4), and for the internal limiting membrane (ILM), I used Brilliant Peel (Fluoron, Ulm, Germany); with this dye and the light source on the Stellaris PC, the ILM can be safely and easily removed using Tano forceps. After ILM removal, I removed the remaining central membrane material.

To perform every type of sutureless vitreoretinal surgery we use the 23-gauge set of instruments, which make posterior vitreous detachment easy. With 23-gauge, I find it easy to remove the ERM and ILM. Using 5000 cpm and the excellent fluidics control on the Stellaris PC, I can approach the retina for careful vitreous removal. The viscous fluid pump allows us to use silicone oil internal tamponade for macular hole (Figure 5). The same 23-gauge approach is preferred for retinal detachments, when it is very important to match fluidics and cutting for close retinal work.

SUMMARY

In my opinion, the Stellaris PC is the first truly complete combined surgical platform and has become my most effective partner in surgery. The machine has features that make the transition from the anterior segment to the posterior segment extraordinarily smooth in terms of safety and efficacy, so surgeons no longer need two systems to perform both surgeries at the highest level. The posterior segment surgeon will find in the Stellaris PC the best partner for advanced vitreoretinal surgery, without the need for a second machine for advanced cataract surgery. ■

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