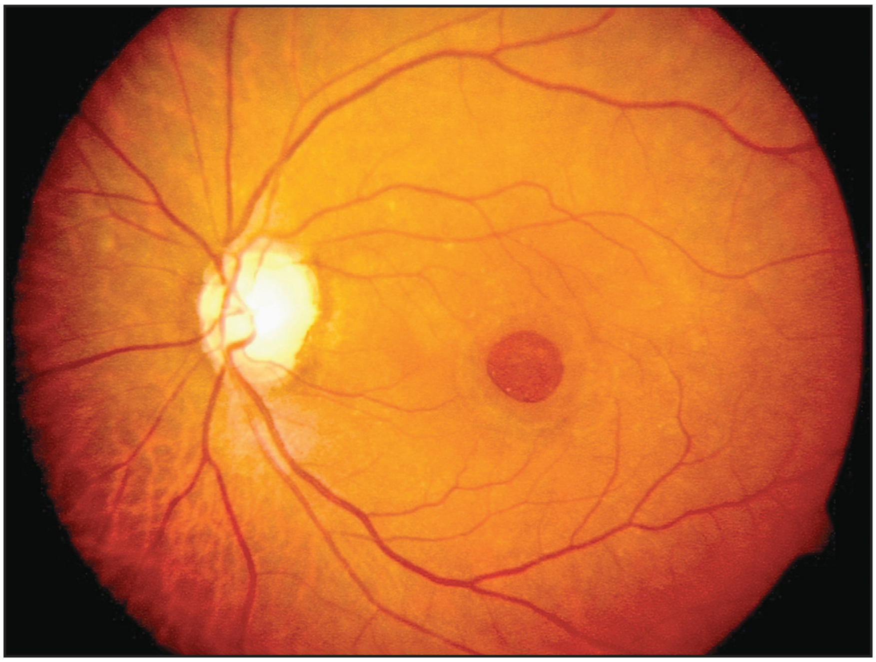
Section VI

Complications in Vitreoretinal Surgery

Avoidance and Management



Chapter 26

Complications in Vitreoretinal Surgery

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The idea of vitreous surgery as conceived by Shafer in 1950 and propagated by David Kasner, in the form of an open-sky vitrectomy, in 1960s was rather hazardous with many complications.[1] A major advancement in the treatment of vitreoretinal diseases was achieved by Machemer and colleagues in 1971[2] with the introduction of pars plana vitrectomy with a single vitreous infusion suction cutter system. Invention of divided system instrumentation by O'Malley gave rise to bimanual vitrectomy. The work performed by Cibis with intravitreal silicone oil, by Norton with intravitreal sulfur hexafluoride gas, and by Chang with heavy liquids has further simplified many steps of the procedure.[3] Now transconjunctival sutureless vitrectomy (TSV) is fast gaining preference among the vitreoretinal specialists. It allows sparing the conjunctival opening and suturing, thus reducing surgical time, and improves overall wound healing. Although present-day vitrectomy has become safer and more reliable than it was ever before, there is still room for improvement. Newer techniques are being introduced at a rapid pace, bringing newer complications that have to be dealt with.

Surgical Anatomy

The vitreous body is a clear gel-like fibrillar meshwork composed of 99% water with the outer cortex being denser.[4] It contains interpenetrating networks of collagen fibrils and hyaluronic acid. While the anterior hyaloid face is strongly attached to the crystalline lens, the posterior hyaloid face is attached at places to the inner limiting membrane of the retina. The strongest attachment is at the vitreous base and relatively weaker attachments exist around the optic disc, at the macula, and along retinal vessels. Sclerotomies made through the pars plana region avoid damage to the pars plicata anteriorly and the vitreous base posteriorly.

Instrumentation

Vitrectomy visualization was initially based only on the use of assistant-held irrigating lenses. This had disadvantages of a restricted field of view as well as difficult handling of the peripheral vitreous. Introduction of the stereoscopic diagonal inverter by Spitznas and Reiver and of the binocular indirect ophthalmo-microscope has popularized the use of contact and noncontact wide-angle viewing systems. These offer a simple, effective, and quick method for illumination of the ora serrata and anterior vitreous in aphakic and pseudophakic eyes during vitrectomy. Self-stabilizing lenses eliminate the need for suturing on the sclera or dependence on the assistant to provide placement. Depending on the step of surgery, the lenses can be used interchangeably. Use of Chandelier illumination system with a 4-port vitrectomy allows bimanuality, further simplifying surgical steps. Even in cases where media does not allow visualization with the standard microscopic systems, microendoscopy provides an alternative, albeit with a loss of resolution and of the third dimension.

Newer cutters that are sharper and have higher cut rates have tried to further reduce the complications. Soft-tip extrusion cannula allows for safe removal of fluid, hemorrhage, gas, or silicone oil from the subretinal space. Closed vitrectomy is known to cause wide fluctuations in the intraocular pressure (IOP) and present-day machines aim to provide precision and

Agarwal A, Jacob S, ed.
Complications in Ocular Surgery (pp 299-308).

better control over fluidics, reducing the chances of intraoperative hypotony or prolonged raised IOP.

Complications and Management

Conjunctiva-Related Complications

Cutting the conjunctiva close to the limbus allows better exposure, causes lesser fibrosis, and also reduces conjunctival shrinkage during resurgeries. Conjunctival closure needs to be end to end so as to ensure quicker healing. Absorbable sutures are preferred even though they may produce slightly more tissue reaction in some patients. Fibrin glue and other acrylic adhesives have been advocated for closing conjunctival wounds, especially in elderly patients. They result in good adaptation and are time saving and effective.

With the advent of sutureless vitrectomy, a lot of conjunctiva and suture-related complications have been sorted out. Conjunctival chemosis, however, is more commonly seen with transconjunctival sclerotomies without the placement of cannulas owing to the leakage of perfusion fluid. Also, with an added risk of the conjunctival epithelium being inadvertently introduced into the vitreous cavity, special attention needs to be paid to conjunctival sterilization.

Sclerotomy-Related Complications

Inadvertent damage may occur to structures adjacent to the site of sclerotomy. Lens damage, ciliary detachment, vitreous base dialysis, or retinal tears may occur while making the sclerotomy or during insertion or removal of instruments. The tip of the sclerotomy blade should always be directed toward the midvitreous and it should be ensured that the internal opening of the infusion cannula is well within the vitreous cavity, prior to starting the infusion, especially in cases with choroidal thickening. A subretinal cannula infusion, once started, can be a disaster for the surgeon. However, if a choroidal detachment does occur, the infusion should be stopped and the cannula freed from any superficial tissue using a microvitreoretinal (MVR) blade or cutter.

Retinal incarceration may occur if an instrument is withdrawn from an eye with raised IOP resulting in rapid egress of fluid that pulls the detached retina along with it. Retina may have to be reposited with a blunt instrument followed by fluid–air exchange and cryotherapy.

All sclerotomy wounds heal with an ingrowth of fibrovascular tissue from the eye wall into the vitreous cavity. Fortunately, only in unusual circumstances does this process become exaggerated and result in what clinicians have termed *fibrovascular ingrowth* (FVIG) with its resultant ocular problems. Postoperatively, FVIG may lead to recurrent vitreous hemorrhage. Although episcleral tissue, scleral fibroblasts, and ciliary epithelium all contribute, the majority of the fibroproliferative healing of a sclerotomy originates from the uvea of the ciliary body. Incarceration of the vitreous into the wound appears to be the culprit and so care needs to be taken to remove any vitreous from the lips of the wound prior to closure. Ultrasound biomicroscopy (UBM) is useful in detecting fibrovascular proliferation at sclerotomy sites. Episcleral sentinel vessels seen externally entering the wound site should raise our suspicions of FVIG; but they neither confirm it nor does their absence rule it out. Anterior peripheral retinal cryotherapy (ARC) combined with cryotherapy of sclerotomy sites might be helpful adjunct procedures in diabetic vitrectomy for inhibition of FVIG and prevention of recurrent vitreous hemorrhage.

Construction of sutureless self-sealing sclerotomies by oblique penetration of the sclera with a 19-gauge MVR blade have been found to be resistant to stretching and tearing, rarely need suturing, and convenient for passage of instruments. They also reduce the risk of intraoperative hypotony following removal of instruments or the infusion cannula. The technique reduces postoperative inflammation, suture-related problems including astigmatism, and allows more rapid rehabilitation. In nonphakic eyes, the trauma of making a sclerotomy site may be avoided with the anterior chamber (AC) infusion approach by way of a paracentesis.

Diathermy should be avoided as far as possible, as it can cause undue scarring and, in rare cases, even surgically induced necrotizing scleritis (SINS) after repeat surgeries has been reported. SINS requires prompt and aggressive immunosuppressive treatment.

Cornea-Related Complications

Corneal complications mainly in the form of epithelial disturbances can occur and are more common in diabetics. Use of irrigating lenses has been linked to an increase in the intraoperative corneal edema, necessitating the débridement of corneal epithelium, and this, in turn, seems to be a major contributor for development of corneal complications. Sew-on lenses with a viscoelastic cushion are less damaging while noncontact lenses may provide the best corneal protection. The type of viscous surface lubricant used with sew-on lenses may also play a significant role. Accidental diathermy burns should be avoided. Corneal complications related to the use of silicone oil will be discussed later. Preservation of anterior lens capsule during pars plana lensectomy has been shown to reduce the risk of corneal endothelial damage especially when combined with long-acting gas tamponade. Subsequent opacification of the anterior capsule may require Nd:YAG capsulotomy for clearing the visual axis.

Persistent corneal epithelial defects may be treated with ointments, pressure patches, or autologous serum eye drops combined with artificial tears and topical antibiotics and generally respond well within 3 days. Defects that fail to heal with conventional therapies may be fitted with an extended-wear gas-permeable scleral lens, keeping in mind the increased risk of microbial keratitis. Re-epithelialization appears to be aided by a combination of oxygenation, moisture, and protection of the fragile epithelium afforded by the scleral lens. Use of topical steroid is usually avoided; however, topical dexamethasone administered 5 times a day may decrease potential stromal scarring without significantly retarding the corneal epithelial healing.

Anterior Chamber Collapse

AC collapse generally occurs in aphakic eyes that underwent vitrectomy with gas tamponade. Presence of preoperative shallow AC, removal of intraocular lens (IOL) as a part of the procedure, occurrence of intraoperative AC collapse, and use of SF_6 were associated with higher risk of AC collapse postoperatively.

Iris-Related Complications

Damage to the iris leading to hemorrhage or iridodialysis may rarely occur due to an improper technique of making a sclerotomy. Postoperative iritis may be treated with topical steroids.

Preoperative presence of retinal neovascularization and absence of panretinal photocoagulation (PRP) and postoperative retinal detachment (RD) are significant risk factors for postoperative iris and angle neovascularization.

In nondiabetic patients who undergo vitrectomy for RD, successful reattachment of retina is the most important factor in the prevention of iris neovascularization. Intravitreal or intracameral injection of antivascular endothelial growth factors (anti-VEGFs) such as bevacizumab can result in rapid regression of iris neovascularization secondary to PDR.

Pupil-Related Complications

In the past, most surgical dilating procedures for intraoperative miosis involved an incision or excision of iris tissue, which was either inadequate or irreversible. Even though currently used wide-angle lenses allow excellent visualization even in miotic pupils, it is always better to ensure proper preoperative dilatation with use of adjuncts such as flurbiprofen or ketorolac.

Intraoperative miosis can be adequately managed by use of epinephrine solution without preservatives either intracamerally (0.1 mL of 1:10,000) or in the infusion fluid or by use of flexible nylon iris retractors or silicone rings. Sphincterectomy may be used as a final resort.

Postoperative inflammation may cause pupillary membranes that do not respond to steroids and may be removed with Nd:YAG laser.

Lens-Related Complications

Development of lenticular opacities after vitrectomy is a major complication often necessitating cataract extraction. The reason for such a change may be related to the over-oxygenation of the lens after removal of the normal vitreous barrier to diffusion of electrolytes. This is supported by the fact that nuclear sclerosis has not been found to progress even at 5 years after a nonvitrectomizing vitreous surgery.

Apart from removal of vitreous itself, the cataract progression depends on the duration of follow-up, use of tamponading agent, and the age and diabetic status of the patient. A transient posterior subcapsular cataract seen in gas tamponade cases in the immediate postoperative period may probably be due to a disruption of fluid balance. Tamponade with silicone oil causes some degree of cataract in almost 100% cases and will be discussed later.

Combined cataract and vitreoretinal surgery with intraocular air or SF_6 gas tamponade also induces severe posterior capsular fibrosis in pseudophakic cases in the early postoperative period presumably due to accumulation of fibrin and proliferation-stimulating factors in the narrow space between the IOL and the air/SF_6–gas bubble.[5] Extended operating times, constant irrigation of lens, and type of irrigating fluid may also be responsible for the lenticular opacities. Cataract formation due to direct mechanical trauma is best avoided with careful surgical technique. Damage generally occurs either with the cutter during removal of the anterior vitreous or at times with the light pipe while working in the far periphery. Modified instruments, such as a curved vitrectomy probe, have been designed to facilitate vitreous base excision. A conservative approach may be warranted for minor lens injuries, but if the damage is significant, especially with rupture of the lens capsule, then it is advisable to remove the lens in the same sitting.

Interestingly, the diabetic status of a patient may play a role in deciding whether to remove the lens as diabetic eyes have been found less likely to require additional vitreoretinal surgery if they are rendered nonphakic before or during vitrectomy.

Glaucoma

Various mechanisms may contribute to a rise in the IOP after vitrectomy.

Raised IOP may occur within 2 to 10 days after vitrectomy for vitreous hemorrhage, mainly due to ghost cell or hemolytic glaucoma. Such an obstruction of the trabecular meshwork (TM) either by degenerated red blood cells or by macrophages laden with red blood cell debris can be prevented by thorough irrigation of the vitreous cavity at the time of vitrectomy, ensuring that no cells and debris are left behind. With the advancement in instrumentation and visualization methods, this incidence has gone down. In case the IOP is not controlled with routine antiglaucoma medication, irrigation of hemolytic debris from the AC with or without a revitrectomy may be done. Elevated IOP has been found to be associated with increasing patient age, expansile gas concentrations, use of C_3F_8, and circumferential scleral buckles. Inability to maintain proper prone positioning after vitrectomy with gas tamponade may lead to pupillary block by the buoyant gas bubble, thus pushing the iris diaphragm anteriorly, in turn leading to permanent peripheral anterior synechiae and intractable secondary glaucoma. To prevent such a pupillary block caused by silicone oil in aphakics, Ando[6] has described an inferior peripheral iridectomy to provide an alternate channel for the aqueous to flow into the AC and this may also be used along with gas tamponade. Presence of lens appears to have a protective role and its removal along with vitrectomy may increase the risk of neovascular glaucoma (NVG). Other factors associated with a significantly increased incidence of postoperative iris neovascularization include severe preoperative retinal neovascularization, absence of preoperative PRP, and postoperative RD.

Iris neovascularization in nondiabetic cases rarely progresses to NVG and so PRP is not indicated in these patients. Retinal reattachment is the most important factor in the prevention and/or resolution of postoperative iris neovascularization.

Treatment of postvitrectomy glaucoma is done initially with standard topical and systemic antiglaucoma medications with YAG peripheral iridotomy or finally cyclodestructive procedures such as cyclophotocoagulation, if needed. Intravitreal or intracameral injection of anti-VEGFs, such as bevacizumab, has shown great promise in reducing the iris and retinal neovascularizations thus preventing the onset of NVG. Anterior segment fluorescein angiography may be used to evaluate the response to therapy. Management of NVG is extremely challenging, often requiring multiple filtration surgeries and destructive procedures such as cyclocryotherapy that often lead to phthisis bulbi. Combined pars plana vitrectomy and placement of a glaucoma drainage implant is often a successful management option in selected patients with refractory glaucoma although visual outcome may still be poor.

Other causes of raised IOP may be related to the chronic postoperative use of topical steroids and postoperative inflammation.

While an increased risk of open-angle glaucoma (OAG) has been found after vitrectomy, in those with established OAG, the number of antiglaucoma medications needed may increase after surgery. Oxidative stress has been hypothesized to have a role in the pathogenesis.

Vitreous Hemorrhage

Vitreous hemorrhage, primary or recurrent, is a common occurrence after diabetic vitrectomy. UBM has been able to detect FVIG in a high proportion of eyes and its use has been advocated as an aid in planning resurgeries. In diabetic vitrectomy, along with PRP, ARC with cryotherapy of sclerotomy sites reduces the incidence of FVIG and PDVH. These adjunct procedures lead to anatomic stabilization and even visual improvement. ARC is often feasible in cases with media opacity that preclude use of endolaser or indirect PRP. The use of these adjuncts, however, should not be routine in all cases of PDR but should be reserved for cases of recurrent vitreous hemorrhage.

Fluid–gas exchange and vitreous cavity lavage are popular, less-invasive methods of treating this kind of recurrent vitreous hemorrhage and may be needed in some cases. The fluid–gas exchange, however, does not offer clear vision immediately after the procedure and has even appeared to exacerbate cataract formation, justifying a period of observation for PDVH.

Use of intravitreal injection of 30 µg of tissue plasminogen activator for lysis of postvitrectomy blood clot, administered 4 days prior to the vitreous cavity lavage, has shown an immediate clearing of the vitreous cavity in 80% of eyes.[7] Postvitrectomy tamponade with 10% C_3F_8 may also be a useful adjunct in the reduction of early PDVH.[8] Intravitreal injection of bevacizumab has also been used preparatory to diabetic vitrectomy, 1 to 3 weeks prior to surgery.

Intraoperative bleed may be prevented by avoiding the vascular component of proliferations while attempting to remove the surrounding traction or by use of prophylactic coagulation. Temporary increase in the infusion pressure or use of endodiathermy usually controls the bleed. Complete removal of posterior vitreous cortex reduces the risk of PDVH by removing the scaffold necessary for proliferation of new vessels and by eliminating vitreous traction on the existing vessels.

Endophthalmitis

Postoperative endophthalmitis is a rare, albeit serious, complication of vitrectomy and, with the recent increased use of intravitreal injections, has been noted in these cases as well.

Over the years, preoperative and intraoperative measures, such as lid hygiene, appropriate surgical draping, and improved surgical technique, have all decreased the incidence of postoperative endophthalmitis. Prophylaxis with topical povidone–iodine, and possibly antibiotics, has further minimized the risk.

In 80% of cases, it is patient's own flora that is responsible for endophthalmitis. In two thirds cases, bacterial agents are gram positive, including *Staphylococcus epidermidis* and *Staphylococcus aureus*, and in one third cases, they are gram negative, including *Pseudomonas*, *Proteus*, or *Klebsiella*.[9,10]

Postvitrectomy bacterial endophthalmitis caused by organisms other than coagulase-negative staphylococci have a poor visual prognosis. Other predictors of visual acuity include baseline acuity of counting fingers or better or culture-negative endophthalmitis.

Instillation of 5% povidone–iodine just prior to commencement of surgery reduces the microbial load from the conjunctival sac. Other methods being empirically practiced include use of preoperative and postoperative topical, intraoperative intracameral, and subconjunctival antibiotics, and use of surgical drapes. In case endophthalmitis does occur in a vitrectomized eye, a needle may be placed through the pars plana to aspirate vitreous fluid for culture and sensitivity. Treatment is based on the endophthalmitis vitrectomy study and consists of intravitreal antibiotics with or without a revitrectomy.[11]

Hypotony

Transient hypotony is common after vitrectomy. With the advent of sutureless vitrectomy, the problem of initial hypotony due to improper sclerotomy is bound to be more especially in the learning curve. But with a tunneled sclerotomy, an airtight closure can be obtained. Chronic hypotony is extremely rare and may be due to leakage through sclerotomy sites or due to a cyclodialysis cleft being formed. Steroids may help relieve any associated inflammation.

Retinal Complications

Cystoid Macular Edema

Removal of vitreous has been known to cause cystoid macular edema (CME) as well make it disappear, showing that its pathogenesis is yet to be understood. The incidence of CME in the presence of a sulcus-fixated posterior chamber IOL implanted at cataract extraction is much less compared to eyes with aphakia or an AC IOL. CME has been found to develop a mean of 4 months after vitrectomy. The prognosis is guarded and long-term treatment with steroid drops, topical cyclooxygenase inhibitor, and posterior sub-Tenon steroid injections may be needed.

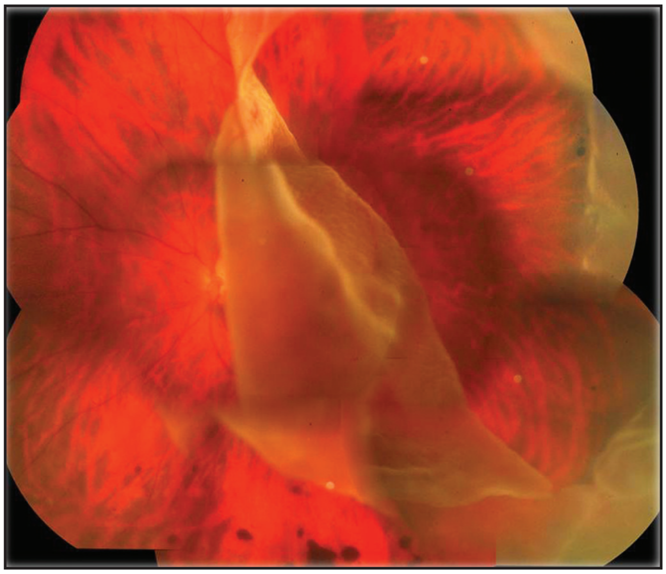

Figure 26-1. Giant retinal tear.

Vascular Occlusion

Prolonged duration of raised IOP during surgery or postoperatively may lead to loss of central or paracentral vision due to vascular occlusion. Compromise in the choroidal circulation may cause an outer retinal layer ischemia.

Retinal Detachment

Iatrogenic retinal breaks leading to postoperative RD is a serious complication of vitrectomy. Retinal breaks may occur following direct mechanical trauma or due to vitreous traction during removal and introduction of instruments or due to excessive pull on existing traction bands. Breaks are more common anterior to the equator and the majority of these occur in relation to the sclerotomy site.

In patients with PDR, using a wide-angle noncontact lens system can reduce the incidence of postoperative RD. Use of an external diaphanoscopic illuminator doubling up as an indenter can help in removal of peripheral vitreous or incarcerated vitreous from sclerotomies within the pars plana. Traction on the retina should be minimized by using higher cut rates and lower suction especially near the vitreous base. Removal of posterior hyaloid face when needed has to be done cautiously starting from the peripapillary region. Standard PRP applied in a complete encircling pattern may prevent macular detachment by restricting the posterior progression of RD due to sclerotomy-related retinal tears that occur after vitrectomy for PDR. At the end of vitrectomy, it is necessary to carefully inspect the peripheral retina with scleral indentation for any missed out or newly created breaks (Figures 26-1 and 26-2).

The introduction of vital dyes for staining has led to better visibility of the internal limiting membrane

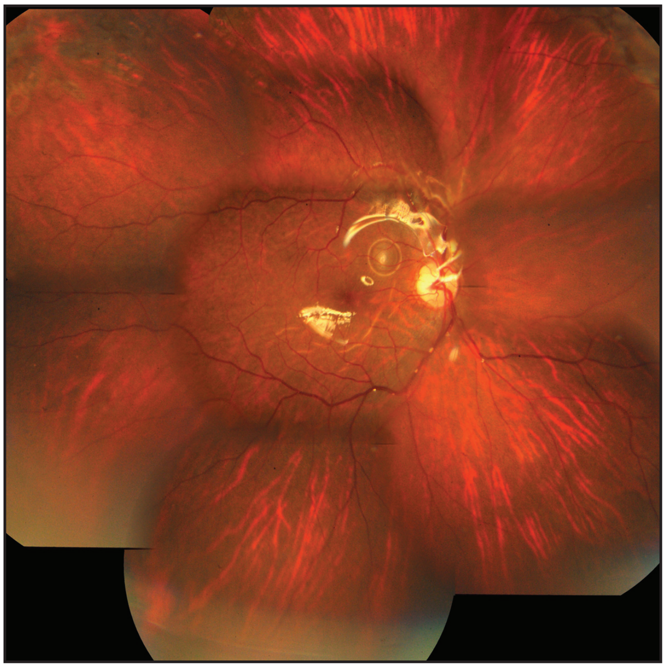

Figure 26-2. Postsurgical appearance in a giant retinal tear.

(ILM), epiretinal membranes, and the posterior hyaloid, potentially making their removal more controllable, easier, and safer. Of all the marking agents used, triamcinolone acetonide best highlights the vitreous without staining the surrounding ocular structures. Both triamcinolone and trypan blue have been found to be useful adjuncts, improving the efficiency and safety of membrane identification and removal.

Questions of the potential toxicity of indocyanine green (ICG) are currently being discussed.[12] ICG has been known to cause pigment epithelial atrophy, disc atrophy, and retinal and choroidal toxicity. However, application of ICG in the air-filled eye versus the fluid-filled eye, short time staining, small volume, and a reduced concentration reduce these possible complications.

Microplasmin, a truncated form of the natural human protein plasmin, is currently undergoing phase II trial for its use in vitrectomy. Results so far have suggested that microplasmin, when injected a week prior to vitrectomy, induces PVD in 50% of patients without the need for either suction or mechanical intervention.[13]

Proliferative Vitreo Retinopathy and Redetachment

Primary vitrectomy with or without gas tamponade and with or without scleral buckle has become a regularly used procedure in complicated rhegmatogenous RDs.

Visual Field Defects

Visual field defects can occur following vitrectomy and gas–fluid exchange for macular hole. Various theories have been proposed to explain this occurrence.

A dense and wedge-shaped visual field defect involving the temporal visual field may be due to trauma to the peripapillary retinal vasculature or nerve fiber layer during elevation of the posterior hyaloid or during aspiration at the time of air–fluid exchange, followed by compression and occlusion of the retinal peripapillary vessels during gas tamponade. It has been suggested that the visual field loss after macular surgery may be reduced if peeling of the posterior hyaloid is confined to the area of the macula so that the hyaloid remains attached at the optic nerve head.

Nasal and peripheral visual field defects have been seen with ICG-assisted ILM peeling, and their incidence appears to depend on the concentration of the ICG solution and/or the exposure time to the retina.

High infusion flow during air–fluid exchange may result in significant retinal damage, sometimes seen as whitening, diagonally opposite to the infusion cannula site. The region of damaged retina may develop a corresponding visual field defect or rarely even a retinal break and detachment. New kinds of infusion cannulas with closed tip and side openings have also been devised to prevent this complication.

Photic Injury

Retinal photic injury may arise from light exposure to the operating microscope or to the fiberoptic endoilluminator, especially during prolonged surgeries for macular hole. Ultraviolet and short-wavelength visible light are more dangerous than longer wavelength light. Although many mild injuries may go unnoticed, fluorescein angiography may demonstrate a previously absent paramacular lesion consistent with a photic injury. It can be reduced by careful planning of vitreous surgery for epimacular membrane removal, using filters, minimizing the length of surgery, keeping the light output low, maintaining maximal light pipe distance from the retina, eccentric orientation of the light pipe, and use of intermittent and variable site illumination techniques.

Choroidal Complications

Suprachoroidal hemorrhage or a choroidal effusion may be seen in up to 0.1% of eyes during or after vitrectomy in the early postoperative period. In the presence of choroidal detachment or endophthalmitis where the choroid is expected to be thickened, it may be wiser to place a longer infusion cannula, while keeping in mind the risk of damaging the lens in a phakic eye. It is necessary to ensure that the tip is in the vitreous cavity and not infusing into the choroid.

The risk factors for suprachoroidal hemorrhage include old age, high myopia, aphakia or pseudophakia, RD, and scleral buckle. Postoperative suprachoroidal

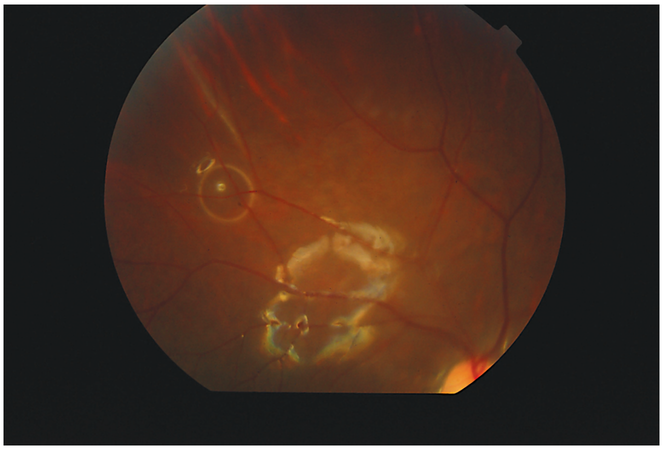

Figure 26-3. Subretinal perfluorocarbon globule.

hemorrhage has a better prognosis than the intraoperative type.

Valsalva maneuver during vitrectomy has been reported to result in massive suprachoroidal hemorrhage and care needs to be taken to prevent prolonged episodes of coughing during surgery.

When such a complication does occur, the infusion needs to be stopped and perfluorocarbon liquids used to displace the hemorrhage or fluid through anterior drainage sclerotomies (Figures 26-3). If the visibility and tone of the eyeball permits, the vitrectomy may be completed. Long-term tamponade with silicone oil is often needed even at times with the use of heavy liquids for the initial postoperative period up to 7 days.

Silicone Oil-Related Complications

Intraoperative

The main concern is overfilling of silicone oil, leading to rupture of zonules with oil entering the AC (Table 26-1). This can be prevented by lowering the infusion pressure just prior to injecting the oil and to stop once oil is seen touching the posterior surface of the lens or refluxing up the infusion line. Silicone oil may at times enter the subretinal space through a retinal break (Figure 26-4). This is best avoided by prior fluid–air exchange and endodrainage of subretinal fluid. However if it occurs, then air is to be replaced with fluid and the oil is aspirated through the break or an anterior retinotomy.

Refractive Changes

In a phakic eye, the silicone oil bubble attains a concave anterior surface and makes the eye hyperopic due to its higher refractive index. Aphakic eyes have a myopic shift due to the convex anterior surface. The degree of myopia increases in the supine position due to separation from the retina and further bulging through the pupil.

Table 26-1. Silicone-Oil Complications
Subconjunctival oil
Oil in AC (nonphakic eyes)
Keratopathy
Inferior iridectomy closure
Glaucoma
Cataract
Silicone oil emulsification
Subretinal silicone oil
Retinal ischemia
Epiretinal and subretinal fibrous membranes
Re-RD

Figure 26-4. Subretinal silicone oil.

Intraocular Lenses

Silicone oil permanently coats a silicone IOL when the two come in contact, interfering with the surgeon's view of the retina and reducing the patient's visual acuity. It has been shown that it is nearly impossible to remove silicone oil from a silicone IOL after short-term or long-term contact, while the same can be readily removed from an acrylic IOL. So it is recommended to use a soft acrylic or polymethyl methacrylate IOL in patients who may require vitreoretinal procedures with silicone oil tamponade. Also, if a silicone IOL is encountered during silicone oil injection, it is advisable to explant it or to rather use an intraocular gas if feasible.

Another issue is trying to calculate the IOL power in a silicone oil-filled eye. The change in sound velocity in oil has to be accounted for during axial length measurement. Although the calculations may be fairly accurate in eyes with normal axial length, some highly myopic eyes with posterior staphyloma show great deviation. Unsuitable formulae and artifacts may be the cause of errors of deviation of refraction. Various modifications of the standard formulae are advocated to account for the change in refractive index. A conversion factor of 0.71 may be used to correct for the apparent increase in axial length induced by silicone oil with a viscosity of 1300 cSt. The meniscus-style or the planoconvex IOL yields the smallest difference between predicted and actual postoperative refraction even after removal of silicone oil.

While some have found sulcus placement of IOL to give a less predictable result than placement in the capsular bag, others have found comparable results regardless of the technique of IOL implantation or the type of silicone oil used.

In cataract surgery combined with silicone oil removal (SOR), an intraoperative biometry after removal of the oil appears to have good predictability for the absolute postoperative refractive error, independent of axial length. Laser interferometry appears to be a feasible and satisfactory accurate noncontact method to calculate IOL power in such eyes, although of lesser value in the presence of an advanced cataract.

Migration of Oil

Long-term retention of silicone oil may lead to its migration into adjacent tissues (eg, subconjunctival or AC migration; Figure 26-5). This may occur through leaking sclerotomies or shunt tubes placed for glaucoma.

Anterior Segment Complications

Almost all eyes with silicone oil tamponade demonstrate some degree of cataract formation, primarily due to mechanical obstruction to diffusion of nutrients. Removal of oil may delay the process but cannot completely prevent it.

Corneal complications can be encountered following vitrectomy with silicone oil injection for cases with severe PVR. The presence of silicone oil in the AC leads to keratopathy in almost all cases by the end of 6 months.

Prognostic factors for development of corneal complications include preoperative aphakia or pseudophakia, preoperative rubeosis iridis, resurgery, corneal touch by silicone oil, and the presence of aqueous cells or aqueous flare. Also the physicochemical characteristics of the silicone oil injected may be an important variable in long-term complications.

Corneal problems are best prevented by avoiding overfill of the oil, filling of AC with air, by performing an inferior iridectomy in aphakics, and by a successful surgical repair of RD with a single operation. If rubeosis iridis or severe aqueous flare is present, preoperative treatment with intense topical and possibly periocular steroids might reduce inflammation and hence corneal damage.

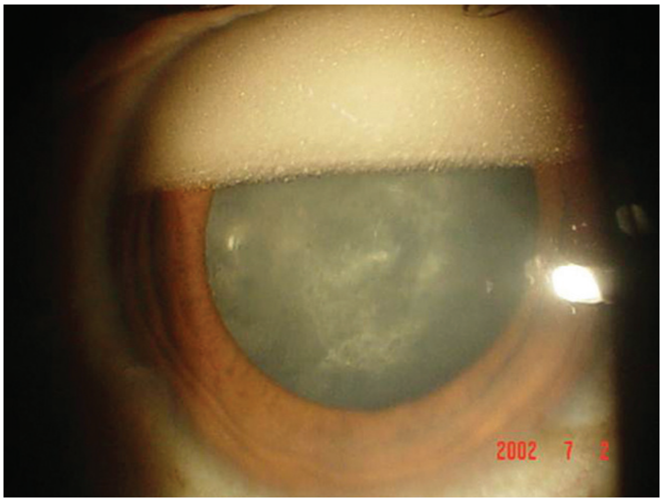

Figure 26-5. Hyperoleon.

Routine performance of an inferior iridectomy in all aphakic eyes appears to lower the incidence of emulsification, keratopathy, and secondary glaucoma. When lensectomy is being performed in the same sitting, it is advisable to leave the anterior capsule intact to help prevent intraoperative and postoperative complications of silicone oil, simplify future IOL placement, and maintain a normal iris appearance.

Removal of silicone oil by passive efflux has shown to cause significant endothelial cell loss and changes in endothelial morphology, which, nevertheless, appear to be well tolerated.

Intraocular Pressure

Hypotony as well as raised IOP may be seen after intravitreal silicone oil injection. Factors prognostic of chronic hypotony include preoperative hypotony, diffuse contraction of the retina anterior to the equator, rubeosis, and large retinal breaks.

The mechanism of IOP increase could be emulsified oil in the AC, pupillary block with closure of inferior iridectomy, or idiopathic angle-closure glaucoma. Some may also present with open-angle glaucoma without silicone oil in the AC.

Independent predictive factors for glaucoma include rubeosis iridis, aphakia, diabetes, oil in AC, and unsettled retina.

Postoperative glaucoma due to pupillary block and angle closure in aphakics can be prevented by an inferior iridectomy. Blockage of TM by emulsified oil droplets can be refractory to medical management and even to removal of oil.

Control of glaucoma when attempted with medical management, SOR, trabeculectomy with mitomycin C, cyclocryotherapy, transscleral cyclophotocoagulation, and/or AC shunting succeeds in most cases while the rest remained refractory. Patients who undergo SOR alone to control IOP are more likely to have persistent elevation of IOP and possibly undergo resurgery for glaucoma, whereas patients who undergo concurrent SOR and glaucoma surgery are more likely to have hypotony.

Apart from the silicone oil-related causes, all the other vitrectomy-related causes should also be considered in an eye with raised IOP and silicone oil.

Emulsification

Emulsification is the formation of silicone oil droplets on the surface of ocular tissues or at the interface between oil and intraocular fluids. It facilitates the migration of oil into AC where it causes further complications. Almost all eyes demonstrate some emulsification after 1 year of surgery. Fibrin and serum are biologically active emulsifiers. Also, the lower the viscosity of silicone, the greater its tendency to emulsify; particularly with viscosities from 1000 to 5000 cSt.

Recurrent Retinal Ddetachment

Inflammatory membranes occurring at the silicone–fluid interface may lead to macular pucker in 30% of cases and also to recurrent tractional RD. Removal of silicone oil in anatomically successful eyes significantly increases the likelihood of improved visual acuity, but also carries a risk of redetachment in one-fourth of cases. This depends on factors such as number of previously unsuccessful RD surgeries, visual acuity before SOR, incomplete removal of vitreous base, absence of an encircling band in eyes with PVR, and the indication for pars plana vitrectomy. It is, however, independent of the technique of SOR and duration of silicone oil endotamponade.

Incidence rates of complications such as keratopathy and hypotony have been found to be lower in eyes with the silicone oil removed.

Conventional silicone oil cannot provide inferior tamponade, which is where PVR most often sets in leading to redetachment. The subsequent use of high-density silicone oil (specific gravity of 1.06 g/mL) to provide support for the inferior retina is being explored as a strategy to reduce the number of reoperations. However, an inflammatory response, resembling granulomatous uveitis, and not responding to steroids may sometimes be seen after such high-density silicone oil endotamponade. It is likely that this vitreous substitute is an immunogenic agent, as after its removal complete resolution of the inflammation has been noted.

Vitrectomy in the Era of Transconjunctival Sutureless Vitrectomy

TSV is a recent advancement in vitreoretinal surgical techniques involving the use of smaller gauge instruments through self-sealing sclerotomies.

Twenty–five-gauge TSV is a minimally invasive technique and appears to reduce the convalescence period and the postoperative inflammatory response while improving patient comfort.

In 20-gauge vitrectomy, repeated introduction and removal of instruments through the sclerotomies results in microtrauma at the pars plana. In contrast, the trocar and cannula system used in 25-gauge vitrectomy system not only avoids the conjunctival incision and cauterization of the scleral bed but also facilitates easy entry, with no trauma to the sclera or the pars plana. As the instruments do not come in contact with the sclera or pars plana, prolonged anesthesia is not required. Sutureless vitrectomies have been carried out under topical anesthesia as well. In the absence of severe congestion, chemosis, or lid swelling, even cosmetically the eye looks much better from the first postoperative day itself.

The success of 25-gauge vitrectomy has been well described, but its application for more complex vitreoretinal diseases, such as complex RD with PVR, has been limited. Although its use has been reported even for tractional RDs in stages 4 and 5 of retinopathy of prematurity, modifications including conjunctival dissection and suturing of conjunctiva and sclerotomies need to be used.

The main limiting factors with the 25-gauge system are the relative lack of instrument rigidity, slower vitreous cutting ability, and suboptimal fluidics, and even blockage of the cutter tip, all inherent to the reduced caliber of the instrumentation.

Intraoperatively, problems such as difficulty in inserting the microcannula, leading to deformity and instability of the microcannula, self-disconnection of the infusion tip resulting in lens damage, and the need to convert to 20-gauge vitrectomy have been noted.

Factors such as the unsutured wounds, postoperative hypotony, and lower infusion rates may contribute to the reported increased risk of endophthalmitis after 25-gauge vitrectomy. An obvious wound leak needs to be sutured. Intravitreal air injection may be used to avoid immediate postoperative hypotony, but despite partial fluid–air exchange, hypotony may still occur. These concerns are similar to the era of phacoemulsification undergoing a shift toward corneal tunnel incisions. However, we feel that these are concerns of a learning curve and as the surgeon gains experience and selects the cases with proper discretion, it probably will not remain a major issue.

Some surgeons have described the technique of 20-gauge sutureless vitrectomy to overcome some of the limitations of 25-gauge systems, but inconsistencies in the application of this technique have limited its widespread use.

Another option is to combine the use of 20-gauge devices through the main port while keeping the

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other two sutureless. This may help to expand the indications for the 25-gauge system. However, postoperative low ocular tension must be addressed by carefully considering surgical indications and prevention measures.

The 23-gauge vitrectomy system has been devised with a view to combine the advantages of decreased surgical trauma and recovery time enjoyed with 25-gauge sutureless vitrectomy with the sturdier instrumentation and improved fluidics of the 20-gauge vitrectomy systems. These characteristics make 23-gauge vitrectomy a promising approach to efficiently and safely tackle the complete range of vitreoretinal surgical procedures with a single system.

Pharmacological Vitrectomy

Pharmacological vitrectomy refers to the use of enzymes in an effort to liquefy vitreous and to weaken the adhesion of vitreous cortex to the ILM during or before performing vitreous surgery. These vitreolytic enzymes may be of great value in complicated or office-procedure vitreoretinal surgery. Plasmin, dispase, and chondroitinase have been used to make the vitreous surgery easier with lesser complications or to avoid vitrectomy. On the other hand, hyaluronidase has been used to facilitate the clearance of vitreous hemorrhage, liquefying vitreous body and developing posterior vitreous detachment.

Conclusion

Vitrectomy has evolved into a high technology-based surgery. New surgical techniques are constantly evolving with the resultant development of new technology and vice versa. Adjunct procedures using laser treatments and fragmatomes have also been refined and are constantly evolving to give improved precision and efficiency to the surgeon.

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