

Managing Surgical Complications in Retina Surgery

With preparation and planning, many complications can be avoided or managed.

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"No matter what measures are taken, doctors will sometimes falter, and it isn't reasonable to ask that we achieve perfection. What is reasonable is to ask that we never cease to aim for it."

Atul Gawande, Complications: A Surgeon's Notes on an Imperfect Science¹

Surgical complications represent dreaded moments in the field of vitreoretinal surgery. To know that one has caused harm to a patient, through an error in judgment or deficit of skill, is a difficult lesson for those who have striven for excellence and perfection since the start of medical training. Complications are, however, an unavoidable aspect of any aspiring surgeons' path, and they happen to the best of surgeons.

As a part of this installment of Fellows' Focus reviewing the complications of vitreous surgery, Rajiv Shah, MD, solicited comments and advice on complications avoidance and management from experienced surgeons. We hope the results below are instructive and helpful for beginning and experienced surgeons alike.

- Rajiv Shah, MD; Francis Char DeCroos, MD; and Adam Gerstenblith, MD

Despite the visceral negative reaction that the very word *complication* evokes, these are moments that offer opportunities for some of the most profound learning and growth of one's career. As Marc Spirn, MD, says, "The key to surgery is to learn to operate in such a way so as to minimize one's complications. Prevention of complications is the best way to manage a complication."

INFECTIONS

One of the worst types of complication of ocular surgery is infection. Endophthalmitis is a potentially dev-

astating complication of any intraocular surgery. Aside from meticulous preparation with povidone-iodine at the start of retina surgery, no other anti-infective measures have been validated in a prospective fashion.²

For most retina surgeries, the rates of infection are low in modern practice. Although reported rates of infection associated with scleral buckle surgery range from 0.5% to 5.6%,³ these numbers reflect the historical evolution of the technique with the introduction of various scleral buckle materials and diathermy. Modern estimates place the rate of endophthalmitis lower in vitrectomy procedures.

The Post-Vitrectomy Endophthalmitis Study Group estimated the frequency of infection with 20-gauge vitrectomy at 0.07%.⁴ Early migration to smaller-incision 23- or 25-gauge vitrectomy raised the question of possible increased rates of infection.⁵ With modifications of wound construction and surgical technique, however, follow-up studies have demonstrated equivalent endophthalmitis rates between 23- or 25-gauge vitrectomy and traditional 20-gauge procedures.⁶

A report by the Microsurgical Task Force emphasizes the need for proper practices to help minimize the risk of endophthalmitis.⁷ According to the Task Force, proper wound construction in 23- or 25-gauge vitrectomy is essential, including the displacement of conjunctiva with a beveled or biplanar wound approach. It is important to prevent vitreous wicks, which may increase the seeding of bacteria into the eye. The use of air or gas tamponade at the conclusion of 23- or 25-gauge vitrectomy may be considered to increase wound stability. Furthermore, the report states, wound suturing is always advisable if there is any suspicion of wound leakage at the end of the case.

ANESTHESIA

With the migration of retina surgery to ambulatory surgery settings, periorbital anesthesia has become a more frequent choice for anesthesia. Complications associated with periorbital anesthesia have included globe perforation, retro-orbital hemorrhage, diplopia secondary to muscle injury, optic neuropathy, and respiratory arrest from inadvertent brain stem anesthesia from dural sheath inoculation.⁸⁻¹⁰

Preoperative patient selection is important in choosing the optimum method of anesthesia. Although the majority of retina surgeries are successfully performed under local anesthesia, complex cases (eg, for ocular trauma or proliferative vitreoretinopathy) in young and relatively healthy patients may be best performed under general anesthesia. Consultation with colleagues in other medical specialties, with instructions to discontinue anticoagulation agents prior to elective cases if there is no serious systemic risk to the patient, is recommended.

Proper technique with retrobulbar and peribulbar injection is essential to minimize many of the complications associated with regional anesthesia. In general, the bevel of the needle should point toward the globe. The angle of injection with respect to the globe should not exceed 45°, and the entire length of a 1.5-inch needle is not necessary to properly anesthetize the globe. (Typically 7/8 of an inch is sufficient to place anesthesia inside the muscle cone if so desired.)

Patients with axial myopia and those on anticoagulation medication, such as warfarin or clopidogrel, may

be better served by a sub-Tenon block. These blocks are performed on the operative field with cut-down to the sub-Tenon space and placement of anesthesia using a blunt tip cannula. This safe and effective method should be considered for these high-risk cases.¹¹

In the presence of retrobulbar hemorrhage, control of hemodynamics is imperative to minimize optic nerve injury. Canthotomy/cantholysis may be necessary for particularly large retrobulbar hemorrhages. Maintenance of acceptable blood pressure levels through coordinated efforts with an anesthesiologist may be necessary to help minimize bleeding.

Carl D. Regillo, MD, recommends aborting the case if possible in the event of an especially large retrobulbar hemorrhage. For small suspected retrobulbar hemorrhages, the infusion pressure can be pulsed to higher pressures periodically during vitrectomy to help tamponade and minimize bleeding. In such cases, it is important to monitor ocular nerve perfusion.

SCLERAL BUCKLE

Regarding scleral buckling, Joseph Maguire, MD, notes that the approach to the conjunctiva is as essential as the placement of the buckle and cryopexy. Careful technique with the handling and closing of conjunctiva is important not just for the case but also for the rest of a patient's life. It is important to avoid stretching the conjunctiva or creating buttonholes when dissecting with Westcott scissors.

Isolating the entire muscle and avoiding splitting of the muscle belly are important to prevent diplopia following a scleral buckle. Once the muscles are isolated, overmanipulation of the muscles while placing the bridge sutures will lead to postoperative pain.

Inspection of the sclera for signs of old trauma and ectasia is necessary to plan your buckle approach. Suspicious quadrants require care with respect to the scleral suture depth. If a quadrant is too thin to accommodate a suture or scleral tunnel, one may need to consider not anchoring the buckle in this quadrant, if the quadrant does not require a buckle to specifically support a break. Rarely, abandoning the scleral buckle procedure entirely and switching to vitrectomy may be necessary if the sclera is too tenuous. Always depress with the tip of the cryoprobe to avoid shaft depression and inadvertent delivery of cryotherapy to the more posterior retina, such as the macula.

During the suturing of the buckle element, Alfred Lucier, MD, emphasizes the importance of proper suture technique. Depress with the needle tip to obtain the initial depth. Once the depth is obtained, flatten the needle to maintain this depth, and always be conscious of the need-

dle depth through the entire pass. Avoid placing sutures near vortex veins, as this can cause suprachoroidal hemorrhage. Sometimes small discontinuous scleral bites are necessary if sutures must be placed around the vortex veins.

Scleral perforation remains the most serious complication for episcleral buckle implants, occurring in 5% of cases.¹² A careful suturing technique and judgment of the sclera being sutured are the best means to prevent this from happening. When a perforation occurs, this typically leads to the drainage of subretinal fluid if the retina is detached. In an attached retina, retinal perforation and hemorrhage are possibilities.

David Fischer, MD, says that perforation with drainage of subretinal fluid is not necessarily a bad outcome. Immediately, it is important to inspect the retina to evaluate the damage. Typically, cryotherapy should be applied to the suture track, and decisions must be made as to whether the scleral buckle or suture track must be moved or if a broader buckle element must be employed in order to support this area of perforation. William Tasman, MD, notes that a buckling suture should be placed beyond the perforation site to allow the buckle to support the perforation site.

Localized hemorrhage following a scleral perforation can be observed if it is not threatening the macula. The most important concern following scleral perforation with inadvertent drainage of subretinal fluid is the possibility of resulting hypotony. Subsequent scleral sutures are more difficult to place in the hypotonous globe, and the risk of perforation increases; smaller scleral bites are advised. Furthermore, hypotony is a setup for a suprachoroidal hemorrhage. Thus, immediately when this type of hypotony is encountered, tension on the bridle sutures will provide immediate temporary control. Then the encircling buckle can be tightened (if this approach is employed), or balanced salt solution can be injected through the pars plana to restore the lost intraocular volume.

The drainage of subretinal fluid remains the step of scleral buckling with the greatest potential for complications. Careful selection for the drainage site will help minimize complications. In general, it is preferable to place drainage sites near the area of maximum subretinal fluid and away from the retinal break. Drainage anterior to the equator and near the horizontal recti muscles is also preferred to avoid the vortex veins. Choosing a drainage site that is in the nasal retina is ideal if subretinal hemorrhage does occur, as this would not threaten the macula. Drainage under the scleral buckle (if an encircling buckle is employed) is advised in case retinal perforation or retinal incarceration occurs. If retinal incarceration or perforation occur during the drainage procedure, cryotherapy of the site and support with the

scleral buckle are necessary. If the site cannot be supported, vitrectomy may be considered.

Subretinal hemorrhage can be observed if it is not threatening the macula. Immediately following the occurrence of subretinal hemorrhage, efforts to increase the intraocular pressure (IOP) either by tension on the bridle sutures or tightening of an encircling buckle are necessary to help tamponade the hemorrhage. For macula-involving subretinal hemorrhages, one may consider concurrent vitrectomy to drain the subretinal hemorrhage or to displace the hemorrhage outside the macula using gas or oil tamponade.

Choroidal hemorrhages with scleral buckles may be observed if they are not "kissing choroidals" and will ultimately augment the buckle effect for a given retinal detachment. Immediate drainage of choroidal hemorrhages at the time of surgery is not possible given the well-formed nature of the hematoma.

Postoperative complications following buckle surgery include diplopia, ischemia, and extrusion. Diplopia may occur with the splitting of muscles or from full-thickness sponge implants. At Wills Eye Institute, typically sponge elements are trimmed in height prior to their placement under the rectus muscles.

Should one encounter postoperative diplopia, Dr. Lucier recommends waiting 3 to 6 months before another surgical intervention to address the diplopia. Referral to a strabismus specialist and the use of prisms may be good temporizing measures. Buckle explantation is always an option, but the risk of subsequent retinal redetachment should be carefully reviewed with the patient. Furthermore, should muscle surgery be necessary, always make yourself available to assist the strabismus specialist as he or she may not feel comfortable working with scleral buckles.

Anterior ischemia is rare complication, reported in 8.2% of eyes in a study of postmortem eyes.¹³ Although ischemia is a multifactorial process (patient vascular risk factors likely play a role), it may be caused by the position of the scleral buckle and the compression of long posterior ciliary arteries or alterations of blood flow in the retina or in the anterior ciliary arteries. This is particularly a concern with encircling scleral buckles; care must be taken not to overtighten the scleral buckle. Upon encountering signs or symptoms of ocular ischemia (eg, pigment dispersion, iris atrophy, pain, or impaired perfusion on angiography), the scleral buckle can be cut or even removed, but the risk of retinal redetachment must be discussed.

Buckle erosion and intrusion into the eye are rarely seen because intrascleral buckles and hydrogel buckles are no longer widely employed. Buckle extrusion also rarely occurs. Dr. Fischer noted that extrusion occurs more commonly with the use of sponge elements.

When sponge elements are used, the Tenon capsule must be closed over the buckle at the muscle insertions in addition to closing the conjunctiva anteriorly.

Should a buckle extrusion occur either from a sponge element or conjunctival erosion over a solid silicone buckle, removal is recommended. This can be accomplished in the office with the help of an operative scope or a surgical loupe, but it is often recommended to perform such procedures in the operating room, where proper anesthesia can be applied. Rarely, scleral rupture can occur, and this is another advantage of planning buckle removal in the OR setting as opposed to the office.

VITRECTOMY

It is clear from national trends in practice that pars plana vitrectomy has become the dominant operative procedure for retinal surgeons.¹⁴ Aside from the factors mentioned above that apply to vitrectomy (anesthesia, infection, wound construction, etc.), the next step after wound construction that has the potential for serious damage to an eye is suprachoroidal or subretinal placement of infusion.

James Vander, MD, stresses that the placement of the infusion line cannot be overlooked, especially in the era of microincisional vitrectomy. He states that an eye can be lost if the infusion is not going into the vitreous cavity. With respect to the infusion trocar, he recommends constructing a smaller tunnel so that the trocar has less chance of slipping out of the vitreous cavity.

Dr. Vander advises, "Always make sure that the tip of the trocar can be visualized. If there is any doubt, infuse an air bubble through the line and see if it goes into the vitreous, or switch to an alternate trocar. Alternatively, one could consider a 6-mm infusion trocar or an anterior chamber infusion line. The 6-mm infusion line will almost certainly strike the crystalline lens, but it is better to have proper placement with the possibility of a lensectomy than to have a suprachoroidal infusion."

Dr. Spirn elaborates further, saying that, even with correct placement, one must be compulsive in checking the infusion line throughout the case. As the surgeon shaves the vitreous skirt or performs scleral depression around the infusion line, the cannula can retract. He says he always turns the microscope light when removing an instrument from the eye to ensure that the infusion line has not slipped. Upon encountering a suprachoroidal infusion, the infusion should be clamped immediately and moved to an alternate port. A recently described technique recommends switching the infusion line to 1 of the other fully inserted cannulas; the infusion trocar is then partially retracted to drain the suprachoroidal infusion.¹⁵

A recent retrospective analysis from the United Kingdom provides perhaps the best view of surgical

complications of vitrectomy in the modern era.¹⁶ In this review of 11 618 vitrectomy operations, 10 937 (94.1%) had no recorded complications. The most common complications were iatrogenic retinal tears (3.2%), lens touch (0.9%), and iatrogenic retinal trauma (0.7%).

With regard to iatrogenic retinal tears, Dr. Maguire notes that it is important to know where your instruments are located at all times. Properly directing the light pipe is perhaps one of the hardest skills for vitreoretinal fellows to master in the beginning, he says. Never operate "in the dark"; one should always have the light cone directed ahead of the vitrectomy cutter.

Unnecessary movement can lead to errors such as retinal trauma or iatrogenic tears. Allen Ho, MD, notes that the improved fluidics of modern vitrectomy with higher cut rates (5000 to 7500 cuts per minute) has created a far greater safety margin when shaving vitreous next to the retina surface. Shave modes (maximum cut rate and proportional vacuum foot pedal control) preset on the vitrectomy machine can lead to safer removal of vitreous and fewer retinal tears, especially in cases involving mobile retina.

Mitchell Fineman, MD, cautions that careful inspection of the peripheral retina remains an important step in elective cases such as macular puckers or macular holes. One must beware of "sticky vitreous" or in cases in which induction of a posterior vitreous detachment is less straightforward, as these are scenarios that can give rise to subtle small retinal tears in the periphery.

Perfluorocarbon is one of the great innovations to aid in complex retinal detachment repair, but it, too, is not without related complications. Retained perfluorocarbon and even subretinal perfluorocarbon are potential complications.

Dr. Ho notes that the most common reason for retained perfluorocarbon is loss of visualization, either through uncontrolled intraocular bleeding, corneal edema, dense cataract, or condensation on the lens implant (particularly with silicone intraocular lenses). Meticulous use of intraocular diathermy is essential when a bleeding vessel is noted, as well as elevation of the IOP when necessary.

One must always be mindful of the reason for using perfluorocarbon. In complex cases in which visualization may be an issue, alternative approaches should be considered, such as lensectomy in the event of cataract, viscoelastic injection to resolve condensation on a lens implant, or use of posterior drainage retinotomy rather than perfluorocarbon injection. It may be helpful to plan for endoscopic vitrectomy if the equipment is readily available. Dr. Fischer provides an alternative suggestion; consider silicone oil infusion with drainage of subretinal fluid and application of laser under silicone oil.

A recent study demonstrated a 4.5-fold increase in the rate of retained perfluorocarbon in microincisional nonvalved vitrectomy compared with traditional 20-gauge surgery.¹⁷ The study authors suggested that higher fluid flow through open 23-gauge cannulas disrupts perfluorocarbon surface tension resulting in formation of small perfluorocarbon bubbles that can enter the subretinal space. Reduction of fluid flow may help prevent this complication.

Omesh Gupta, MD, MBA, is quick to note that valved cannulas create a safer environment for the use of perfluorocarbon. If valved cannulas are unavailable, the infusion line should be clamped any time an instrument is removed from the eye. Furthermore, he recommends efficiency of movements; with each removal of an instrument, turbulent flow is inevitable. The surgical goal should be achieved prior to removing an instrument from the eye. If subretinal perfluorocarbon is encountered, a 36-gauge subretinal cannula or drainage retinotomy near the perfluorocarbon bubble may be necessary for removal.

All surgeons face complications. However, with proper planning—based on this helpful advice from our attending surgeons and other esteemed colleagues—it is hoped that a minimal rate of complication can be achieved. ■

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