Complications of Surgery for Diabetic Retinopathy

BY TOM H WILLIAMSON, MD, MBChB, FRCS, FRCPHTH

Although diabetic retinopathy was one of the first conditions for which pars plana vitrectomy (PPV) was employed, vitreoretinal surgery for complications of diabetes remains a challenge. In general, success rates for visual improvement are 90% for vitreous hemorrhage, 60% for those with tractional retinal detachment and may be as low as 30% to 40% for those with combined tractional and rhegmatogenous retinal detachment. Much of this reduction in success rate is due to the underlying condition of diabetic retinopathy with ischemia and cystoid macular edema (CME) implicated in poor visual recovery however surgical complications also contribute. Complications for surgery can be divided into preoperative complications and postoperative complications but the two are inter-linked. It is therefore easier to consider the eye from its anterior segment to posterior segment.

ANTERIOR SEGMENT COMPLICATIONS

Commencing with the cornea, these patients have a loose corneal epithelium that is prone to separation. The surgical use of a contact lens system for visualization of the retina in prolonged surgery may cause corneal edema, reducing the surgeon’s ability to view the retina. In such cases, debridement of the epithelium is performed to clear the cornea. The more frequent use of noncontact visualization systems, however, has significantly reduced the need to remove the corneal epithelium during surgery.

Cataract after vitrectomy is common, particularly in patients older than 50 years. For reasons that are not clearly understood, however, patients with diabetes are less likely to develop cataracts post-vitrectomy. Thus, for these patients a combined vitrectomy/phacoemulsification procedure is unnecessary. It has been postulated that cataracts do not form in these patients because of reduced oxidative stress on the lens proteins in the ischemic diabetic eye. Performing vitrectomy increases the partial oxygen pressure (PO₂) in the vitreous. It is possible that the vitreous functions to keep oxygen tension low around the lens, and that this reduces the oxidative stress on the lens fibers. In ischemic eyes, such as in patients with diabetes, the PO₂ is lower—and remains lower than normal—even after vitrectomy. For this reason, the diabetic eye may be protected from postoperative cataract. The reduced performance of combined cataract and vitrectomy surgery in these patients translates to a risk of lens touch, in my series 1.3% in these patients.

POSTERIOR SEGMENT COMPLICATIONS

Early Vitreous Hemorrhage

Postoperative vitreous hemorrhage in these patients can be divided into early (within 2 months of surgery) and late. Early hemorrhage can be present in up to 60% of patients in the postoperative period. Surgical technique is important; dissection of neovascular mem-

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branes can cause preoperative hemorrhage, which reduces the ability of the surgeon to perform further membranectomy (reduces the view and fibrin adheres to retina). In very rare cases bleeding can be uncontrollable leading to risk of abandonment of surgery. In order to control bleeding during diabetic surgery I recommend the following:

- Elevate the infusion bottle to try to minimize the bleed from vessels but to watch the optic nerve which has a fragile circulation and is prone to shut down with raised intraocular pressure.
- Apply pressure to the bleeding point with a blunt instrument such as a flute needle tip. The pressure must be applied for enough time to allow the blood to clot (Figure 1). Perioperatively, this may seem like a very long time as the instrument must be kept still on the blood vessel to avoid tearing of the retina. I generally suggest a 1-minute minimum application of pressure to allow the hole in the blood vessel to plug.
- Endodiathermy can be applied; technically it has a tendency to damage the retina in the area of application. Removal of the endodiathermy tip can be associated with removal of the plug of fibrin causing a recurrence of bleeding. Thus, I use do not use endodiathermy frequently.

Once a clot has been formed, it can become very adherent to the fragile diabetic retina. It may be tempting to aspirate the clot and pull if off the bleeding blood vessel. This removes the plug of fibrin, however, which allows hemostasis. It is therefore more appropriate to trim the blood clot down to the bleeding point leaving a small piece of clot at the blood vessel to maintain the plugging effect of the thrombus.

Other strategies have been described to deal with perioperative bleeding such as heparin infusion into the eye to prevent clotting and allow washout of any bleeding. In addition, some surgeons have described inserting adrenaline into the infusion bottle, although this carries a distinct risk of shutting down vessels.

Late Vitreous Hemorrhage

Late vitreous hemorrhage occurs in 12% to 27% of patients treated for diabetic retinopathy; I warn my patients that there is a 10% chance of a repeat vitrectomy for removal of postoperative blood. It is worth informing your patient that over the long term—1 year to 18 months—some patients will experience small bleeds which last a few a days at a time. Gradually, these reduce with frequency; however, a few may require a further vitrectomy. More laser therapy can be applied and is usually enough to prevent further bleeding.

Sclerotomy Site Neovascularization

There are a number of descriptions of sclerotomy site neovascularization in these patients. This remains a controversial topic as a potential cause of late postoperative bleeding. Some surgeons will perform dissection of the sclerotomy site neovascularization in an attempt to reduce further bleeding. These patients, however, are also having repeat vitrectomy and more laser application—I personally find this is enough to prevent further bleeds without specific dissection of the sclerotomy sites.7-9 Other types of potential hemorrhage in this kind of surgery remain very low. In my series of 264 tractional retinal detachments I had no choroidal hemorrhages, small or large.

Iatrogenic Breaks

Iatrogenic breaks are common in patients receiving delamination surgery with en bloc dissection of neovascular membranes, caused by traction on membranes, direct incision of the retina from scissors or cutters or insertion of instruments into sclerotomy entry sites.10-12 Some patients have schitic retina from traction from

Figure 1. Applying pressure to a bleeding vessel.
neovascular membranes—a feature that is prone to retinal breaks during delamination (Figure 2).

Segmentation or En Bloc
Originally, segmentation of difficult-to-remove membranes was performed. It was then determined, however, that it would be more advantageous to remove all membranes from the retina, i.e, en bloc dissection. One school of thought suggests complete removal of membranes, dealing with the consequences of any iatrogenic breaks that are created afterward. The other school suggests segmentation of membranes too difficult to remove in an attempt to reduce the iatrogenic break rate. The described rates of breaks vary from 20% to 35% and in my practice, I choose to create the iatrogenic break and deal with it rather than leave membrane behind on the retina. Persistent membrane may cause reproliferation of the membrane and further traction on the retina. If the membrane is close to the disc or the macula, contraction causes striae in the macula, reducing vision. Once a break is created, the membrane close to the break must be removed, as traction of the membrane on the breakage postoperatively will cause lifting and retinal detachment. Instead, flatten the break, laser, and tamponade with intraocular gas.

Rhegmatogenous Retinal Detachment
Rhegmatogenous retinal detachment postoperatively can occur despite panretinal photocoagulation and multiple laser scars. Retinal detachment rates have been described in 1% to 9% of patients. These patients usually have iris neovascularization (83%). The surgeon should reoperate as quickly as possible because proliferative vitreoretinopathy (PVR) occurs rapidly and can lead to an inoperable situation. In a patient who develops this complication without PVR, vitrectomy and gas can be performed. However more often, PVR has been initiated and the patient will require vitrectomy and oil. In general, silicone oil is not ideal for use in a diabetic eye and I prefer to never use it as a first-line tamponade and I instead use silicone oil at subsequent surgery if the patient’s eye is complicated by retinal detachment. The risk of these catastrophic outcomes with silicone oil appears to be lower at the second surgery, possibly because the laser has had a chance to reduce the relative ischemia of the retina. Silicone oil remains a risky agent, however, to use in a diabetic eye and should only be used when absolutely necessary. Maneuvers, such as retinectomy in these eyes, are fraught with risk but may sometimes be necessary if the retina will not reattach with tamponade alone.

Much remains that we do not know about the response of the diabetic eye to surgery. In simple cases of vitreous hemorrhage, success rates are high but in patients with tractional retinal detachment, with dissection off the delicate retina and optic nerve, there may be residual effects on the retina that we as yet cannot quantify. Often a good surgical result is not followed by a good visual result. Optic atrophy is commonly seen and the retina is often thin.
PREOPERATIVE MEASURES

Intravitreal antivascular endothelial growth factor agents (anti-VEGF), such as bevacizumab (Avastin, Genentech, Inc.), have been successfully used preoperatively to reduce perioperative complications, such as perioperative bleeding, in tractional retinal detachments. Injected 1 week before tractional retinal detachment surgery, anti-VEGF agents can reduce the blood flow in membranes and contraction of the membrane.

Surgical innovations include the development of high-speed cutters with cutting orifices that are nearer to the end of the cutter tip. These may allow closer dissection of membranes from the retina, and may reduce the need for scissor-delamination prior to the removal of the membranes. Surgery for very complex tractional retinal detachments and those with rhegmatogenous retinal detachment can be aided by surgery with a bimanual approach. The use of chandelier illumination systems allows the surgeon to use forceps in one hand and scissors in the other to remove membranes from mobile retina, hopefully reducing iatrogenic tear formation in these complex cases.

The catastrophe rate in these patients is 3% to 4% for phthisis bulbi and 7% for risk of no perception of light in some series. The risk of no perception of light is increased in those who have iris neovascularization, postoperative hemorrhage and macular ischemia. These patients with often severe diabetic complications systemically have a reduced 5 year survival to somewhere between 68% and 80%. In conclusion, vitrectomy for complications of diabetic retinopathy is complex surgery. Although cataract formation is reduced postoperatively this is replaced by an increased rate of postoperative vitreous hemorrhage and iatrogenic tear formation, especially in patients with traction retinal detachment. If patients develop retinal detachment postoperatively iris neovascularization is common.

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21. Gandhi JS, Tan LT, Pearce I, Charles SJ. Bevacizumab (Avastin, Genentech, Inc.) has been successfully used preoperatively to reduce perioperative complications, such as perioperative bleeding, in tractional retinal detachments. Injected 1 week before tractional retinal detachment surgery, anti-VEGF agents can reduce the blood flow in membranes and contraction of the membrane. Surgical innovations include the development of high-speed cutters with cutting orifices that are nearer to the end of the cutter tip. These may allow closer dissection of membranes from the retina, and may reduce the need for scissor-delamination prior to the removal of the membranes. Surgery for very complex tractional retinal detachments and those with rhegmatogenous retinal detachment can be aided by surgery with a bimanual approach. The use of chandelier illumination systems allows the surgeon to use forceps in one hand and scissors in the other to remove membranes from mobile retina, hopefully reducing iatrogenic tear formation in these complex cases. The catastrophe rate in these patients is 3% to 4% for phthisis bulbi and 7% for risk of no perception of light in some series. The risk of no perception of light is increased in those who have iris neovascularization, postoperative hemorrhage and macular ischemia. These patients with often severe diabetic complications systemically have a reduced 5 year survival to somewhere between 68% and 80%. In conclusion, vitrectomy for complications of diabetic retinopathy is complex surgery. Although cataract formation is reduced postoperatively this is replaced by an increased rate of postoperative vitreous hemorrhage and iatrogenic tear formation, especially in patients with traction retinal detachment. If patients develop retinal detachment postoperatively iris neovascularization is common.

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