Tractional retinal detachment (TRD) may occur in a number of conditions, such as proliferative diabetic retinopathy (PDR), retinal vein occlusion, trauma, sickling hemoglobinopathies, and retinopathy of prematurity. Progressive retinal ischemia leads to pathologic secretion of growth factors, especially VEGF. These growth factors lead to the development of fragile new vessels from the existing retinal veins. The new vessels then break through the internal limiting membrane and grow along the surface of the retina and into the scaffold of the posterior hyaloid face. Subsequently, glial cell proliferation encases these vessels in fibrous tissue. With time, the vitreous can contract and exert tractional forces on the retina via these fibrogial connections, leading to a TRD. This cascade of events explains why an eye in a patient with diabetes is protected from a TRD if a complete posterior vitreous detachment (PVD) has occurred before any evidence of neovascularization. Therefore, the chief surgical goal of TRD repair includes complete release of the hyaloid with dissection of all tractional fibrous membranes. All strategies employed are geared toward avoiding breaks in the ischemic, fragile retina.

PREOPERATIVE EVALUATION
Spectral-domain optical coherence tomography (OCT) imaging is helpful in assessing the level and severity of the membranes and can provide clues regarding the location of potential spaces where safe dissection or initiation of membrane removal can be performed. Color and red-free photographs are also helpful and should be reviewed the night before surgery.

INTRAOPERATIVE TECHNIQUE
If vitreous hemorrhage is present, it is cleared in the standard fashion. Attention is then turned toward tackling the peripheral vitreous (Video; eyetube.net/?v=opool.)

The vitreous in diabetic and other TRDs differs significantly from the vitreous in an eye with routine rhegmatogenous retinal detachment (RRD). Most cases of RRD will have a complete PVD, whereas this is uncommon in TRDs. In TRDs, the vitreous is usually detached in the midperiphery, but multiple attachments remain at the posterior pole, thus forming a vitreous cone.

The first step in any case of TRD should be to trim and release for 360° the peripheral vitreous cone. One should avoid going directly to the nerve to induce a PVD or initiating membrane dissection until the peripheral vitreous cone has been trimmed, as pulling on the vitreous at the nerve without trimming the peripheral vitreous cone can lead to iatrogenic tears in the peripheral retina.

Removal of vitreous should begin around the two superiorly placed sclerostomies and then proceed to the vitreous cone, which should be trimmed in the midperiphery, or wherever there is maximal separation between the vitreous and the underlying retina, using the highest

At a Glance
- 360° trimming of the peripheral vitreous cone is the essential first step in tractional retinal detachment surgery.
- Segmentation and delamination of the membranes and release of the posterior hyaloid is the second major step.
- Incomplete removal of the hyaloid is the most common cause of failure.
cut rate and least amount of suction possible. The cutter port should face the surface of the vitreous while the cone is trimmed.

In some patients, the peripheral vitreous may be tightly adherent to the retina in some areas. In such cases, one should apply a little more suction with the cutter to release the vitreous from the surface of the retina. If this seems difficult, one can slide the cutter tip through the adjacent trimmed edge of the cone to lift the adherent vitreous. Rarely, one might need to use a pick or scissors to do the same if one fails with the cutter.

In phakic patients, one should be mindful of the crystalline lens while trimming the vitreous cone, especially when reaching across the lens with the cutter (Figure 1). To avoid touching the lens, one should switch hands or have an experienced assistant perform scleral depression to reach the peripheral vitreous on the opposite side.

If the lens is touched and a cataract begins obscuring the view to the posterior pole, there should be no hesitation to perform a pars plana lensectomy. The anterior capsule should be kept intact, and a secondary intraocular lens can be placed at a later date.

Once the peripheral vitreous has been released, attention is turned to the posterior pole. There are two ways of handling the fibrous tractional membranes: an outside-in or an inside-out technique. In the outside-in technique, dissection of the membranes starts at the arcades and comes toward the optic nerve, whereas in the inside-out technique, dissection starts from the optic nerve and goes toward the periphery. We prefer the inside-out technique, as the retina is strongest near the nerve and the junction of the nerve with the retina provides strong counter traction during dissection.

Before commencing at the optic nerve, we switch from the wide-field viewing system to a flat contact lens, as this provides increased magnification and stereopsis (Figure 2). This is also a good time to review the OCT to locate potential spaces or safe areas to initiate the dissection. Using a retinal pick, the fibrovascular tissue attached to the optic nerve head is gently dissected and elevated from the nerve head. Once the nerve is free, segmentation and delamination are performed to remove all the membranes as described below.

SEGMENTATION AND DELAMINATION

Segmentation and delamination are the main surgical techniques in membrane removal. In simple terms, segmentation is cutting the fibrotic epiretinal membranes into small segments or islands, and delamination involves removal of these segments from the surface of the retina.

The old technique of en bloc dissection should be avoided. En bloc dissection basically means removal of the posterior vitreous and tractional membranes in one piece. That is, one goes directly to the optic nerve and induces a vitreous detachment and hopes the membranes will separate from the retina along with the vitreous as one single sheet. This technique invariably leads to multiple large breaks due to the tight adherence of the tractional membranes to the ischemic, fragile retina. The best way to tackle these membranes is to remove them piecemeal rather than as a single sheet.

Segmentation can be accomplished either with the cutter or scissors. Advances in small-gauge cutters, such as location of the port closer to the tip and improved fluidics, have allowed surgeons to use these instruments as vertical scissors. To initiate the segmentation process, a blunt-tipped pick or the cutter tip is first carefully guided.
between the membrane and the retina, and space is created by moving the instrument sideways to sever the adhesions. Because these membranes are elastic, they usually scroll up a little once the adhesions are severed. The cutter port can then be inserted in the space between the membrane and retina to cut or segment the membrane.

In eyes in which the membrane is firmly stuck down to the retina and the pick or cutter is unable to dissect a plane safely, we switch to curved scissors. Scissors segmentation is performed by placing one blade under the membrane (ie, between the retina and the membrane) and the other blade above the membrane. Curved scissors are safer than vertical scissors because the blade width is much greater than the blade thickness.

After we have created a segment or island, we proceed to delaminate or remove that segment from the surface of the retina. Delamination can be performed several ways, depending on the firmness of the adhesion of the segment to the underlying retina. If the segment is small with weak adhesions, it can be peeled with forceps, or the cutter can be used as forceps to suction the edge and peel it. The light pipe can sometimes be used to turn over the edge of the fibrovascular membrane to better visualize the undersurface of the membrane.

If the segmented membrane is highly adherent to the underlying retina, we will then switch to curved scissors to avoid creating iatrogenic breaks. Previously, we used horizontal scissors, but curved scissors are safer because the curvature of the scissors matches the curvature of the retina. We introduce the scissors under the membrane with the blades slightly open and then cut the attachment points (fibrovascular pegs) between the membrane and the retina to free the membrane. A spreading action with the scissors under the membrane is avoided, as this causes traction without cutting. The aim is to cut the adhesions and not tear them.

The same techniques of segmentation and delamination are applied for the remaining membranes until all have been removed. If a break occurs, it is immediately marked with gentle diathermy and the dissection is continued. The cornea can get cloudy during long surgeries, and we do not hesitate to gently deepithelialize the central cornea to improve the view.

**BIMANUAL SURGERY**

In a bimanual technique, both hands are actively used for dissection under visualization provided by a self-retaining illuminating system (ie, a chandelier lighting system).

Prior to the advent of chandelier systems, lighted instruments such as illuminated picks, cutters, and scissors were used but were not found to be helpful. The main disadvantage of lighted instruments is that they are held close to the retina and can cause phototoxicity. Other problems with these instruments include glare and the technical challenges of incorporating a light fiber into fine, small-gauge vitrectomy instruments.

We currently perform bimanual surgery in less than 10% of cases. It is used only if we feel that the methods described above might induce multiple breaks during dissection. After the chandelier is inserted at 6 o’clock, forceps are introduced through one of the superior ports, and the edge of the membrane is lifted while the cutter or scissors are used in the other hand to segment or delaminate the membrane.

While one is performing bimanual surgery, it is important to remember that some of the subtle specular clues

*Video* (Continued on page 40)
and shadows that are seen in focal illumination with a light pipe are lost. One has to be careful not to rotate the eye while cutting with the scissors because this rotatory force can be transmitted to the forceps holding the membrane and create a break. This problem can be avoided by pivoting the scissors carefully around the sclerotomy or by grasping the membrane with the forceps only when the scissors are approximately in the correct position to cut.

Once all areas of traction and fibrovascular proliferation are removed, a thorough, safe shaving of the peripheral vitreous is performed. After all residual vitreous is removed, panretinal photocoagulation is performed. Laser marks should be as light as possible, spaced one laser mark apart (Figure 3). We prefer a curved laser probe, especially in phakic patients. Care should be taken to avoid the 3- and 9-o’clock hours to prevent damage to the ciliary nerves and avoid postoperative tonic pupil.

A 360° scleral depression is performed to look for breaks. If no breaks are seen, gas tamponade is not needed, but if breaks are noted, we use 14% C₃F₈. In occasional cases with large multiple breaks, or if the patient cannot comply with postoperative positioning, silicone oil can be used.

ROLE OF ANTI-VEGF AGENTS AND HEMOSTASIS

We use preoperative anti-VEGF drugs only if we notice large, active neovascular fronds, and they are given after the patient has obtained medical clearance for the surgery. We refrain from using them if there is more of a fibrous than a neovascular component to the detachment. We prefer to do the injection 3 to 5 days before the surgery. If bleeding is encountered during surgery, we raise the bottle height or gently compress the bleeder with the tip of the cutter. Rarely, for large bleeders, endodiathermy may be needed to stop the bleeding.

CONCLUSION

TRD repair is probably the most challenging ocular surgery to perform. By utilizing the techniques and algorithm described above, one will be better able to tackle these complex cases with relative ease.

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