

The One-drop Technique for ILM Peeling

BY WAMIDH SIMAWI, MD

Internal limiting membrane (ILM) removal is recognized as a useful surgical approach for treatment of different macular surface diseases. The surgical technique, however, for ILM peeling is demanding in terms of time and skill. Challenges include poor visibility of the thin transparent membrane and the small dimensions and the sensitivity of the macular tissue, which increase the risk of iatrogenic damage from surgical manipulation. These factors increase the risk of iatrogenic damage.

INDICATIONS FOR ILM PEELING

The indications for ILM peeling have been expanded to many different macular conditions. The primary indications include idiopathic macular hole and macular pucker (primary or secondary). Recently, studies and reports have described the effectiveness of ILM removal in pseudo-hole cases in myopic eyes,¹ chronic diabetic macular edema (DME),²⁻⁸ and vein occlusive diseases such as central retinal vein occlusion (CRVO) or branch retinal vein occlusion (BRVO).³⁻¹⁴

It has been recommended that ILM peeling be performed after silicone oil removal to prevent late postoperative complication such as secondary macular pucker.¹⁵

PATHOGENESIS

The mechanical and degenerative theories of macular surface pathologies have been investigated in many centers worldwide. Newly formed collagen and glial cells, macrophages, myofibroblasts, fibrocytes, retinal pigment

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cells, and fibrous astrocytes are responsible for the tangential traction and have been identified on the ILM and the epiretinal membrane (ERM) surface.¹⁶⁻¹⁸ The collagen formation and cellular matrix cause wrinkling of the ILM and increase in tangential traction to the foveal tissue. This traction, originating in the acellular prefoveal vitreous, appears to be the initial cause of anterior-posterior traction that leads to hole formation. Further hole enlargement is due to myofibroblastic contraction on the ILM.

The sophisticated development of optical coherence tomography (OCT) technology has revolutionized our understanding of the nature of these degenerative conditions. The OCT has become the gold standard in clinical evaluation of the disease's staging and a reliable method of estimating surgical outcomes.

Since the initial report of vitreous surgery for idiopathic macular hole by Wendel et al,¹⁹ different ILM peeling techniques have been described that improve the anatomic closure of the macular hole.

I have developed the one-drop technique, which uses a minimal amount of staining for visualization and a minimal amount of surgical manipulation.

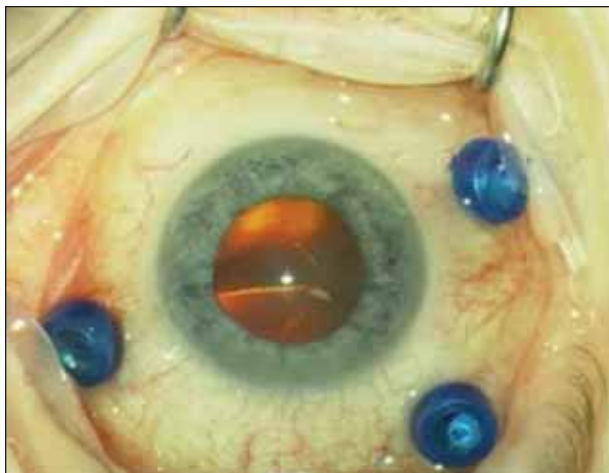


Figure 1. 23-gauge MIVS. Trocar insertion with a closed system. The infusion cannula is always located in the inferotemporal quadrant. The conjunctiva is displaced, and the sclerotomy is watertight.

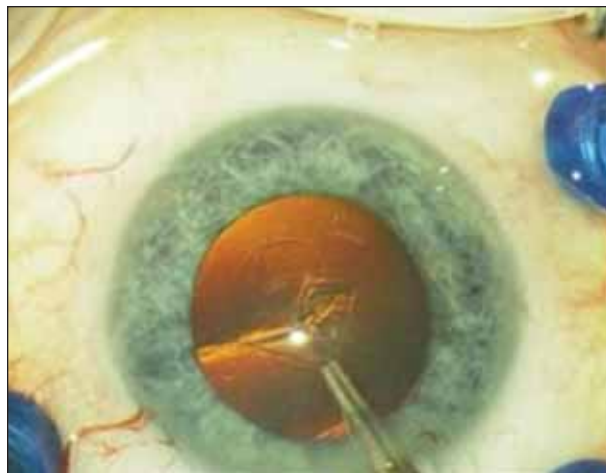


Figure 2. Clear corneal incisions. The main incision is 2.75 mm with two sideports at 1.1 mm each for bimanual irrigation and aspiration of cortex. The capsulorhexis has a diameter of less than 5.5 mm.

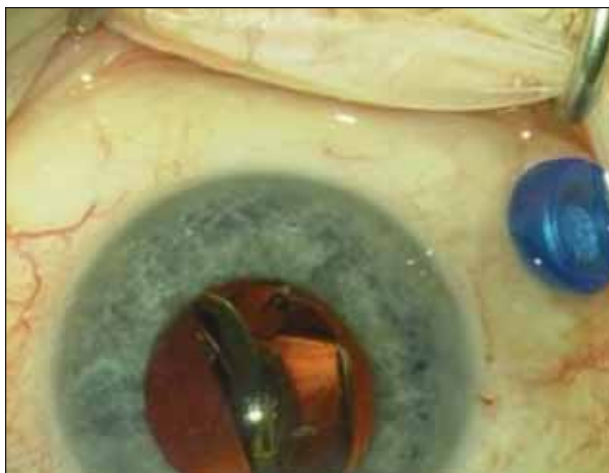


Figure 3. After phaco removal of cataract and implantation of an AcrySof Single-Piece IOL (Alcon Laboratories, Inc.) in the bag with good centration and stability. The IOL optic must be covered by anterior capsulorhexis edge to prevent IOL displacement and posterior capsular opacification.

PHACOEMULSIFICATION/IOL IMPLANTATION

All cases in this report were performed under local anesthesia and general sedation with combined phacoemulsification and three-port 23-gauge microincisional vitrectomy surgery (MIVS). I prefer to insert the 23-gauge transconjunctival ports prior to beginning phacoemulsification. Special attention must be paid to secure the infusion cannula within the vitreous, and we use conjunctival displacement to construct sclero-

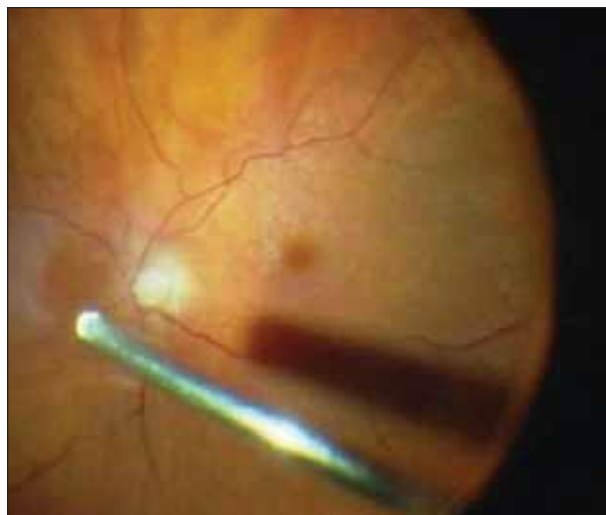


Figure 4. Core vitrectomy: 1500 cpm, aspiration 300 cc/min. The Weiss ring and the posterior hyaloid membrane are apparent. We cut the posterior hyaloid at 2000 cpm and 100 cc/min.

tomies with watertight architecture (Figure 1). A one- or two-step sclerotomy technique can be employed. For cataract removal, I create a clear corneal incision (Figure 2) and after phaco I implant a posterior-chamber IOL. The IOL must be positioned behind the anterior capsulorhexis edge to prevent dislocations or malpositioning, especially in macular hole cases, in which we will be using a gas bubble and having the patient posture postoperatively (Figure 3). I do not fill the anterior chamber with an ophthalmic viscosurgical device. I recommend slight hydration of the corneal

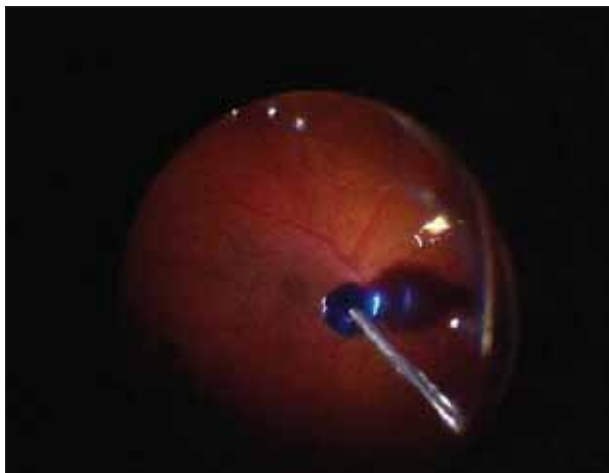


Figure 5. Air-fluid exchange. We placing one drop of MonoBlue or Brilliant Blue carefully. There is no need to inject it forcibly to the macular surface.

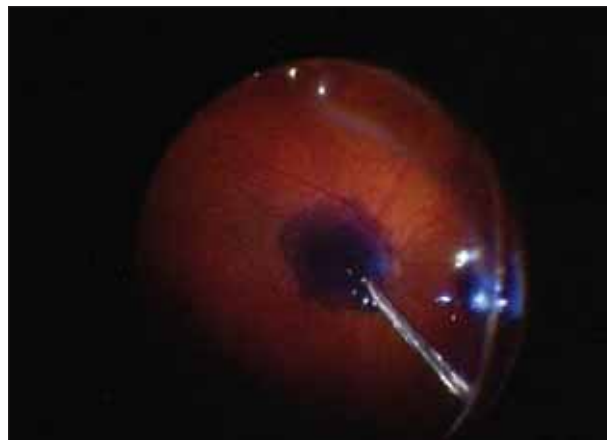


Figure 6. As the first drop falls down we can clearly see that one drop is enough to cover the area between arcades. With gentle movement to the globe, we help the dye to spread above a bigger surface to color the ILM or ERM.

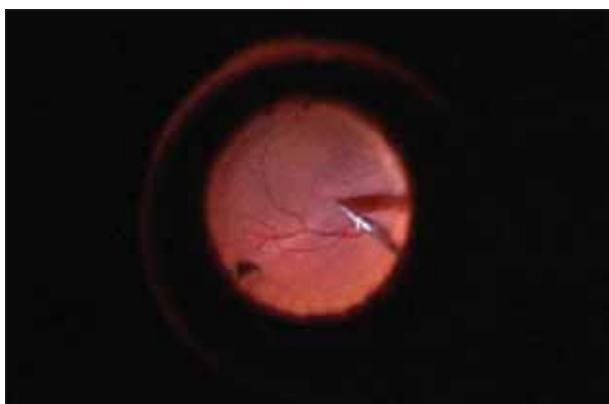


Figure 7. A disposable high-resolution contact lens is placed to get high-definition and 3D views and achieve good visual feed back from the structures of the macula. High magnification is not recommended. The MVR blade is used to dissect the ILM or ERM gently with a slow movement outside the maculopapillary bundle and away from the axons.

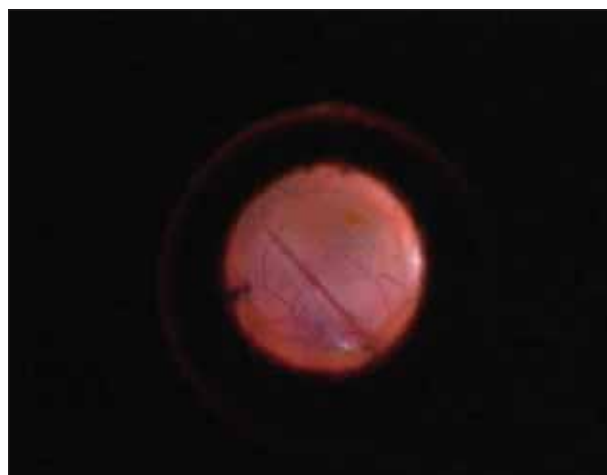


Figure 8. Divergence angles of illumination. There is a wide-diameter macularhexis between vascular arcades. By guiding the peeling, we can perform the removal of adequate size and shape.

incision to maintain an appropriate anterior chamber depth during the posterior segment portion of the surgery. I suture our corneal incisions only if there is significant leakage and flattening of the anterior chamber. I use a coating on the cornea to maintain visual clarity to the posterior pole.

VITRECTOMY

Before beginning vitrectomy, I recommend rechecking the position of the infusion cannula to ensure that it is stable within the vitreous cavity.

I start the core vitrectomy using a moderate cutting rate and high vacuum (Figure 4). If a posterior vitreous

detachment (PVD) exists, I do not force with shaving the vitreous base to enhance the removal of posterior hyaloid; in the absence of PVD, I induce a PVD by using my cutter for posterior hyaloid separation. Posterior hyaloid removal requires good visualization of the retinal periphery and adequate machine settings—I use high cut rates and low vacuum to reduce the mechanical stress on the surface. To reduce sclerotomy-associated vitreous incarceration and postoperative retina detachment or endophthalmitis, I am careful to remove all visible vitreous fibers with the cutter from trocars until I get free passage of balanced salt solution. Bimanual scleral indentation can be used to detect any

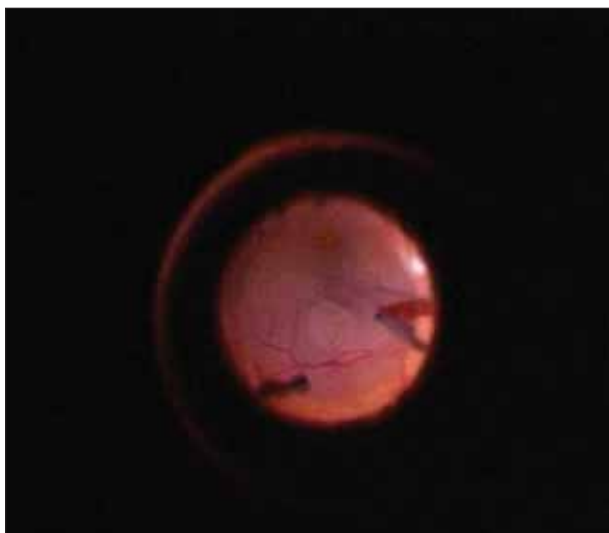


Figure 9. Grasping the free edge of ILM, we peel slowly and circumferentially with a multiple grasp-and-peel technique.

retinal breaks or holes in the periphery, with special attention paid to areas of thinning or lattice dystrophies. For areas that are suspect, I apply endolaser.

The 3D settings on the Accurus Surgical System (Alcon Laboratories, Inc.) are effective in reducing surgical time and surgically induced trauma to ocular tissues when combined with good footpedal balance and eye-hand coordination.

ILM REMOVAL

ILM removal can be divided into two stages. The first is dependent on the vitrectomy system in terms of its ability to cut and remove the vitreous and posterior hyaloid membrane. The second, and most important, stage of ILM removal almost always relies on the manual skills of the surgeon. After completing the vitrectomy, I perform fluid-air exchange with passive aspiration using the Charles Flute cannula (BD Visitec, Waltham, MA). I introduce the dye to the surface of the macula carefully with one drop, mixing either Mono Blue 0.25% (trypan blue; Arcad Ophtha, Launac, France) or Brilliant Peel (trypan blue; Geuder, Heidelberg, Germany) with a small amount of residual balanced salt solution (Figure 5). Gentle rotational movements can be applied to encourage the dye to spread over the surface of the macula, painting the area between the vascular arcades (Figure 6). Using passive aspiration, the dye can be easily removed after 10 to 15 seconds without reducing the quality of visualization. The coating that is applied to the cornea, along with the use of a disposable central contact lens, provides 3D high definition of the macular structures.



Figure 10. We grasp the proximal edge and peel the ILM. It is important to avoid ILM tearing to finish the removal with one strip. Use the uniform illumination to see the two-color difference.

STEPS IN THE SURGICAL TECHNIQUE

After the dye is removed and air-fluid exchange is performed, the ultrastructures are exposed and, with the help of an MVR blade, the first flap or strip of the ILM or ERM can be gently manipulated and dissected (Figure 7). This first flap must be made temporally or diagonally parallel to the axons in the parafoveal area. I grip the most visible edge of the ILM with Eckhardt forceps (DORC, Zuidland, Netherlands) which are designed to grasp the ILM with minimal contact with the underlying retinal surface. The light source must be adjusted away from the fovea in an angled manner to minimize phototoxicity. Additionally, the angulation of light creates a better shadow for visualization of the distance between the retina and the instruments. The various divergence angles can also be used for spot or floodlight effect—wide illumination produces more uniform contrast (Figure 8).

Grasping the ILM by the edge, as noted above, allows me to slow the movement (Figure 9). It is crucial to grasp the proximal edge (the edge nearest to the retinal surface) of the flap and to guide the movement away from the retina; it is also important not to tear the flap (Figure 10). By controlling the speed with which the ILM is peeled and the direction of movement, it is easier to maintain control over the shape and diameter of the macular hole with minimal touch to the retinal layer. During ILM removal, one must avoid the small areas of preretinal bleeding that will appear. As peeling progresses, it becomes easier to identify the stained ILM from the naked retinal surface. The gentle manipulation of the ILM tissue without tearing gives the opportunity to

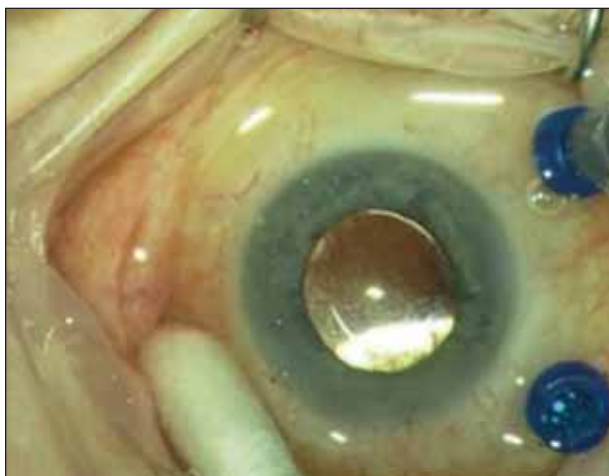


Figure 11. Removal of the trocars one by one is followed by gentle messaging.

complete the peel in one strip. If some residual ILM material is attached to the macular hole edge, it is important that it not be forced because the macular tissue may be torn radially. The best approach is to cut it with the vitrector or curved scissors. I do not recommend aspirating with the cannula because this can lead to a permanent defect in the retinal pigment epithelial (RPE) layer.

In cases of macular pucker, the ERM edges can be easy to identify and begin to grasp and peel. Peeling both the ERM and the underlying ILM is possible to perform using the same technique. If the ERM is separated from the ILM, dye staining can be repeated. In cases of diffuse DME, the adhesion of the ILM to the macula is stronger, and the manipulation must be more delicate. Repeated staining may be indicated. At the close of the procedure, I recommend removing the trocars one by one and using a gentle massage technique. I switch off the infusion before removing the last cannula (Figure 11). I apply an injection of antibiotic mixed with steroid deep into the sub-Tenon space (Figure 12).

SPECIAL SURGICAL CONSIDERATIONS

Following are some points for consideration using the one-drop technique:

- The visualization of ILM vs ERM can depend on the degree of retinal pigmentation; it has been noticed by many surgeons that ILM removal is easier in dark pigmented eyes.
- Some surgeons have reported green light illumination to be beneficial, but I have no experience with this technique.
- Indocyanine-green (ICG)-assisted ILM peeling remains the gold standard worldwide, but this has



Figure 12. Final view of the eye.

proved to be toxic to the retinal ganglion cells and the RPE.

- Blood- and triamcinolone-assisted ILM peeling have not been proved superior to ICG.
- A diamond-dusted sweeper is an effective device to peel strong adhesive ILM, particularly in cases of DME and young patients.
- In the majority of cases, we have noticed that peeling can cause insignificant axon edema, which results in two different shades of colors in the naked retina and the remaining membrane. These color differences can provide valuable feedback regarding the peeled area's zone, shape, and diameter.

• Several experts recommend that peeling should begin temporally at least two disc diameters outside the parafoveal zone, especially in cases of macular hole with elevated edges seen on OCT. Peeling must be performed away from the hole, outside the maculopapillary bundle, and preferably not over the large retinal vessel.

• The diameter of the macular hole must include the area between the arcades to release the mechanical traction. Hypothetically, a large diameter will relieve the macular surface, and the micro-migration of the tissue will cause the anatomic closure of the hole.

ADVANTAGES/DISADVANTAGES

Using dye under air has the following advantages: 1) only a small amount of dye is required; 2) the dye needs to stay in the eye for only a short duration of time; 3) it is easy to inject and easy to remove; 4) it can be placed selectively above the zone that will be peeled; 5) there is minimal penetration of the dye into the retinal tissues; 6) it is easy to spread over the macular surface; 7) there is no incidence of staining the lens capsule or loss of

visualization; 7) it has low toxicity and lowers the risk of phototoxicity; and 8) the dye makes it easy to identify the edges of the ILM.

The possible disadvantages of this technique include:

1) in some cases, more than one or two drops is required; 2) if the staining is found to be inadequate, a repeat procedure will be necessary; and 3) after air-fluid exchange some air bubbles may escape above the anterior hyaloid, necessitating an anterior vitrectomy and the reduction of dye concentration above the macular surface.

The one-drop technique requires careful manual dexterity, but the learning curve is relatively short for the experienced vitreoretinal surgeon. There are studies suggesting trypan blue has a less toxic effect on retinal cells compared with ICG staining.^{20,21} By minimizing the duration of exposure and the amount we use, however, any residual harmful effects of trypan blue to the retinal ganglion cells, retinal pigment epithelium, and photoreceptors can be minimized.

CONCLUSION

The goals of macular hole surgery are to achieve anatomic closure of the hole and to achieve good functional results. Minimizing the use and duration of use of staining dye can dramatically reduce the toxic chemical damage to the retinal ganglion cells and RPE. The correct use of the illumination in terms of its intensity and angulation can minimize the phototoxicity to sensitive photoreceptors. It is important to correctly understand forceps design, the multiple grasp-and-peel technique, and how to guide the speed and direction to skillfully manipulate the ILM and ERM with the least iatrogenic trauma to the retinal surface. This technique will provide better safety and lower toxicity, and it is my hope that ICG be retired permanently from retinal surgery. ■

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