“Interface Vitrectomy” Offers an Alternative for Surgery

By leaving surface tension–management agents in the eye, many vitreoretinal procedures can be better performed.

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Surface tension–management agents (ie, air, silicone oil and liquid perfluorocarbon) are all immiscible in aqueous media. Vitreous humor, sub retinal fluid, blood, fibrin and infusion fluid are all aqueous substances. The central point of this column is to emphasize that virtually all surgical steps, including epiretinal membrane management, removal of vitreoretinal traction and retinectomy, can be performed and are often best accomplished with air, silicone oil or perfluorocarbon in the eye.

Because the surgical processes are performed at the interface between surface tension agents and the retina, this approach is called interface vitrectomy, a term I coined.

PERFLUOROCARBON INTERFACE VITRECTOMY

As discussed in a previous column, gas, silicone oil and liquid perfluorocarbons have markedly different properties. The viscosity of n-perfluoro-octane (PFO) is approximately two-thirds that of the infusion fluid, but it has almost twice the specific gravity; clearly, high specific gravity explains why PFO sinks and infusion fluid, subretinal fluid, blood and mobile retina (giant breaks) float.

The high mass explains two other effects important in the context of performing surgery with PFO in the eye: gravitational stabilization and inertial stabilization of the retina (Figure 1). Liquid perfluorocarbons produce a gravitational force, which acts somewhat like a large, gentle hand pushing the retina downward, thereby offsetting dissection forces and unfolding retinal folds, as well as separating retina from vitreous.
Inertial stabilization is based on the equation $F = ma$ (force = mass x acceleration); thus, higher mass reduces acceleration. PFO and the retina at the interface move less in response to pulsatile vitreoretinal traction from the cutter opening and closing than they would with an infusion fluid–filled eye.

In addition, the retina may move more slowly in response to dissection forces, such as forceps membrane peeling and scissors segmentation and delamination. It is, of course, essential to remove as much peripheral vitreous traction as possible in retinal detachment cases — a step that is usually performed prior to injecting PFO. Residual vitreous traction can be easily seen and removed at the PFO-vitreous interface; hence, interface vitrectomy is combined with retinal stabilization.

Many surgeons peel ERM after injecting PFO; while this is effective at reducing retinal motion, it can result in subretinal fluid and, worse yet, subretinal PFO if insufficient attention is paid to injection technique and/or retinal defects, allowing access to the subretinal space.

**My preferred method of injecting PFO uses the MedOne 25-gauge dual-bore cannula on the Alcon VFC, powered by the Accurus or Constellation platforms.** I like this method because injecting with too short of a needle guarantees having multiple small bubbles when the tip is not kept inside the injected PFO, and injecting with a tight fit between a single-bore needle and cannula lumen always produces high IOP because there is no way for fluid to egress.
The dual-bore cannula I use eliminates these problems. The dual-bore cannula allows fluid egress through a proximal port to prevent increased intraocular pressure as PFO is injected. PFO injection occurs from the tip of the dual-bore cannula. An initial small bubble should be injected at the optic nerve head, the dual-bore cannula tip should be placed at the anterior surface of the this bubble, and the cannula should be withdrawn in pace with bubble enlargement.

If the cannula is withdrawn above the bubble, multiple small bubbles may occur, which might gain entry to the subretinal space. If the cannula tip remains near the retina during injection, PFO will be lost through the egress port. The surgeon must remain mindful of retinal stiffness vs the relatively modest interfacial surface tension of PFO, as a tradeoff to prevent submacular PFO when dissecting ERM. The VFC injection pressure should be set at 10 psi, not the 80 psi used for silicone oil.

SILICONE OIL INTERFACE VITRECTOMY

Silicone oil has 1,000 to 5,000 times the viscosity of infusion fluid, explaining why 80 psi of injection pressure is needed to inject this fluid through short 23/25-gauge cannulas inserted through a cannula. Silicone oil produces viscous dampening, which acts like a shock absorber (Figure 2). Viscous frictional force is proportional to velocity; therefore, the pulsatile vitreoretinal traction produced by the cutter opening and closing is reduced when working at the interface between oil and the retina during reoperations.
Figure 2. Silicone oil stabilizes the retina by viscous dampening.

For over three decades, I have recommended leaving silicone oil in place when reoperating for epimacular membrane (EMM), proliferative vitreoretinopathy, traumatic scarring, or recurrent glial membranes in diabetic traction retinal detachment scenarios with silicone oil in place. Forceps membrane peeling, scissors segmentation/delamination, retinectomy, resection or forceps removal of subretinal proliferation, drainage of subretinal fluid, and endolaser all work very well “under oil.”

Unfortunately, many surgeons still remove oil when reoperating, dissect epiretinal membranes under BSS or PFO, and reinject the oil at the end of the case. Oil eliminates intraocular lens fogging, a problem with fluid-air exchange in IOL cases with a YAG capsulotomy. More importantly, reoperation under oil provides realistic assessment of the tradeoff between residual retinal stiffness and the interfacial surface tension of oil. Oil also confines bleeding into the interface.

Some surgeons have suggested that visualization is problematic when reoperating without removing silicone oil, but I have not found this to be an issue as long as the IOP was maintained to prevent corneal folding. Plugging of the cutter and tubing is rarely a problem unless oil is admixed with lens material when lensectomy is attempted. Oil can leak from the sclerotomies in myopic eyes with thin sclera due to enlargement of the wounds caused by tool manipulation; suturing is certainly needed in some cases.

During interface vitrectomy with oil present, the vacuum should be used at the highest level (600 mm Hg on the Accurus and 650 mm Hg on the Constellation platform) and vacuum only applied after the cutter has traversed the oil bubble, and the port is at the oil-retinal interface. Simultaneous retinectomy and removal of subretinal fluid is often required in PVR cases, especially for inferior PVR, and it works well with this technique. Residual peripheral vitreoretinal traction can be easily visualized and removed at the oil interface as well.

Removal of subretinal fluid, residual vitreous and/or an aqueous layer on the retinal surface requires volume replacement with oil. This is best accomplished not by infusing oil through a 20-gauge infusion cannula but by sequentially (tool exchange) adding oil through the 25-g superotemporal cannula each time the IOP drops due to fluid and tissue removal. No infusion cannula port is placed; this 25-gauge, two-port technique can be done with 23-gauge as well.

Care must be taken to use valved cannulas or to insert tools quickly after the cannulas are placed to prevent the costly loss of oil. It is not necessary to reinject oil in EMM cases; two-port 25-gauge technique with Alcon DSP ILM forceps in the surgeon's dominant hand and the endoilluminator in the other hand works well.

AIR INTERFACE VITRECTOMY

Air produces spring dampening of retinal movement, in contrast to the viscous dampening produced by oil and by the inertial and gravitational stabilization produced by PFO (Figure 3).
Despite our best efforts to remove all vitreous before proceeding to fluid-air exchange, residual vitreous can occasionally be visualized at the air-vitreous interface at this point in the procedure.

**Figure 3. Air stabilizes the retina by spring dampening.**

Wide-angle illumination (**Figure 4**) and visualization systems, as well as triamcinolone particulate marking of the vitreous, have fortunately reduced the likelihood of residual vitreous, but lens opacities, corneal problems, posterior capsular opacification and small pupils can hinder peripheral vitreous removal, which is so essential in retinal detachment cases.
Figure 4. Wide-angle illumination has reduced the likelihood of residual vitreous.

If vitreous is noted during fluid-air exchange, the soft-tip cannula should be removed, the vitreous cutter reintroduced, and fluid-air exchange continued. Residual vitreous removal including frank vitreoretinal traction can be safely removed at the air interface.

Vitrectomy “under air” is also effective for leaking trauma wounds, as well as for confining bleeding. If bleeding obstructs the view of the retina, fluid-air exchange can allow for identification of and endolaser can allow for coagulation of the bleeding source. Air optics enables increased peripheral visualization in most scenarios.

If air comes into contact with the posterior surface of an intraocular lens because a capsule defect exists, and the anterior vitreous cortex has been interrupted, IOL fogging will occur. In this situation, it is better to go back to BSS infusion to eliminate fogging, attach the retina with PFO, apply endolaser to all retina breaks, and then perform PFO-gas exchange (isoexpansive 25% SF₆ or 18% C₃F₈), with the soft-tip cannula at the optic cup.

If oil was planned, and IOL fogging occurs, inject the oil through the superotemporal cannula while allowing air egress through the superonasal cannula. When the oil reaches the posterior surface of the intraocular lens, fogging will disappear, and internal drainage of subretinal fluid,
endolaser and additional traction management, if needed, can be performed “under oil,” as
described above. If fluid-air exchange is performed in aphakic cases with any striate keratopathy,
the view will be highly distorted, and surgery “under air” will not be possible.

GAS OR OIL IN THE ANTERIOR CHAMBER

If oil or air-gas enters the anterior chamber in phakic or pseudophakic cases, it is usually best
managed by making a paracentesis with the phaco side-port blade (20-gauge MVR tip) and
injecting viscoelastic into the anterior chamber to express the oil or gas bubble around the
injection cannula. The viscoelastic can be left in place at the end of the case and topical
glaucoma medications used for approximately one week. RP

REFERENCES

1. Charles S. Management of subretinal fluid and surface tension agents during vitreoretinal

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