

# Vitrectomy for Management of Complications of Diabetic Retinopathy

The best technology is the one that works best in your hands.

BY VIRGILIO MORALES-CANTON, MD

Since early in its history, pars plana vitrectomy (PPV) surgery has been used to address the complications of diabetic retinopathy. In the more than 40 years since the description of closed PPV by Machemer and colleagues,<sup>1</sup> many changes and much progress in vitrectomy technologies have taken place. Since that time, we have seen the introduction of endolaser, endo-cauterization, better visualization systems, faster cutting speeds, smaller caliber instruments, better guillotine cutting, and better illumination.

Of these many advances, some of the most important for management of diabetic retinopathy have been changes in illumination systems, including the introduction of chandelier systems; better fluidics, through the use of peristaltic pumps and duty cycle controls; and better viewing systems, such as noncontact lens systems. In addition, the introduction of smaller-gauge instrumentation has revolutionized the way we treat all surgical patients, particularly those with diabetic retinopathy. Faster cutting speeds on redesigned vitrectomy probes have allowed us to perform maneuvers we never could before, getting the tip very close to membranes and shaving them without injuring the tissue beneath.

This article describes some current technologies for vitrectomy and my own preferences for management of the complications of diabetic retinopathy with vitrectomy surgery. It is important to note that the best technology is the one that works best in your hands. Therefore, it

---

Excellent 23- and 25-gauge instrumentation is now available, and we may be approaching the era of 27 gauge, although we are not there just yet.

---

is vital to stay up to date with current instrumentation and techniques to allow you to make informed decisions about which ones work best for you and your patients.

## ADVANCING TECHNOLOGIES

**Smaller gauges.** Excellent 23- and 25-gauge instrumentation is now available, and we may be approaching the era of 27 gauge, although we are not there just yet. These smaller-diameter instruments have led to better fluidics. For vitrectomy surgery in diabetics, design improvements placing the port closer to the tip of the vitrectomy probe have changed everything. Today, it is hard to imagine performing vitrectomy in an uncomplicated diabetic case with the old 20-gauge port designs.

**Cutting.** The Constellation Vision System (Alcon) with 25+ instrumentation and the Oertli OS3 (Oertli

Courtesy Didier Ducourneau

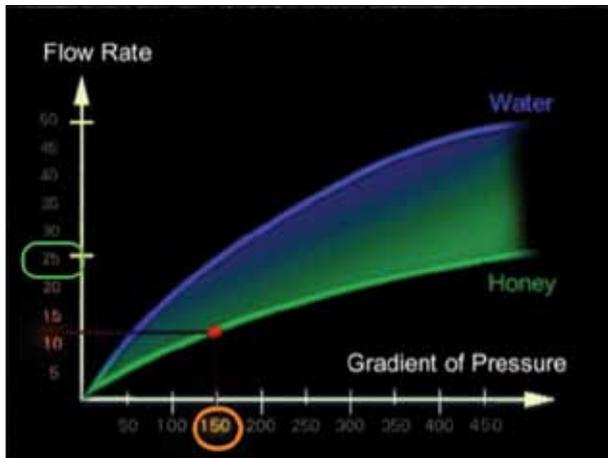
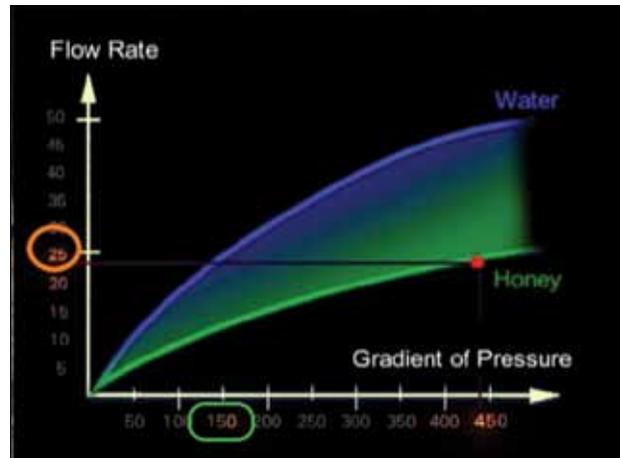


Figure 1. With a venturi pump set at 150 mm Hg vacuum, when the vitrectomy probe is in water, the flow is 25 cc/min. When the probe is moved into honey (representing vitreous gel), the flow decreases.

Instruments) are examples of current vitrectomy machines that provide excellent cutting capabilities. Both of these platforms use dual pneumatic cutting technology on their vitrectomy probes, allowing cutting rates of 3000 to 7500 cpm. At speeds this high, the port must open and close very rapidly; this did not occur reliably with older spring-dependent vitrector technologies. The dual pneumatic instrumentation represents a significant improvement.

**Pumps.** Venturi and peristaltic pumps have different characteristics, advantages and disadvantages, and surgeons may prefer type one over the other. Venturi pumps are vacuum-controlled, and peristaltic pumps are flow-controlled. The diagrams in Figures 1 and 2 show the difference. Experiments were conducted in an eye model filled with water and honey to represent the different consistencies of fluid and gel in the vitreous. With a vacuum-controlled venturi machine, if a vacuum of 150 mm Hg is preselected, this results in a flow of 25 cc/min when the probe is in water—or, in the human eye, irrigation solution. If the probe is moved into the honey—representing the vitreous gel in these experiments—the flow rate goes down, as shown by the red dot on the lower green line. With a peristaltic pump, again with the vacuum set at 150 mm Hg, the flow is 25 cc/min in water. When the probe is moved into the honey, however, the machine changes the vacuum to a preselected 450 mm Hg, and the flow stays the same. This is why those who prefer peristaltic pumps say these machines are more reliable and faster, because they respond to the situation in the eye and keep material flowing more steadily through the port.



Courtesy Didier Ducourneau

Figure 2. With a peristaltic pump set at 150 mm Hg vacuum, when the vitrectomy probe is in water, again the flow is 25 cc/min. When the probe is moved into honey, the vacuum is increased to a higher preset level, and the flow stays the same.

**Viewing systems.** A number of noncontact lens systems are available for use in vitrectomy, including the Binocular Indirect Ophthalmic Microscope (BIOM; Oculus), the Eibos (Haag-Streit), the Resight Fundus Viewing System (Carl Zeiss Meditec), the Peyman-Wessels-Landers 132 D Upright Vitrectomy Lens (Ocular Instruments), the Merlin lens system (Volk Optical), and the Wide Angle Viewing System (WAVS; Insight Instruments).

When Maurice V. Landers III, MD, asked me to contribute to a paper on a noncontact widefield viewing system for vitrectomy several years ago,<sup>2</sup> he asked me, “Why do you prefer noncontact viewing systems?” In an attempt to formulate an answer, I was looking at surgical videos in fast-forward mode, and I noticed that with a noncontact lens system, the visualization was very fluid. By contrast, in cases in which a contact lens system was used, there were many moments when blood or air obscured the view, so visualization was not as good. At the time of the surgery I did not notice this, but when the videos were played fast-forward it became evident. This is the main reason I prefer noncontact viewing systems: the superior visualization. There can also be disadvantages, such as condensation forming on the lens if it gets too close to the cornea.

**Illumination.** Chandelier systems have greatly improved illumination in vitrectomy, and they allow bimanual maneuvers because 1 hand does not have to be devoted to holding the light source. There are many types of chandelier available; I prefer dual chandeliers because they eliminate problems with shadows and provide wide-angle illumination. Light sources include



**Figure 3.** Use of valved trocars improves fluidics and decreases vitreous incarceration.

xenon, mercury vapor, and LED. The latter is a good light source because it minimizes phototoxicity and creates less heat than the other light sources.

**Pharmacology.** Chen and Park were the first to describe the use of intravitreal bevacizumab (Avastin, Genentech) as a preoperative adjunct for complicated cases in severe proliferative diabetic retinopathy.<sup>3</sup> There have since been many other reports.

Oshima and colleagues<sup>4</sup> retrospectively compared the results of vitrectomy in 2 groups of complex diabetic patients: 1 group (33 eyes) underwent 20-gauge vitrectomy, and the other (38 eyes) underwent microincision vitrectomy and adjunctive intravitreal bevacizumab. Comparable anatomic and visual success was achieved in both groups, but surgical times were shorter and there were fewer complications in the group receiving bevacizumab and small-gauge surgery. However, the study authors cautioned that rapid progression of preexisting tractional retinal detachment was seen in 7 eyes (18%) that received bevacizumab.

**Footpedal.** The introduction of dual-linear footpedal control has significantly improved intraoperative control of surgical parameters during vitrectomy. The biaxial movement allows simultaneous surgeon control of aspiration through up-and-down motion and preselected cutting rate with side-to-side motion. It has always been said that to be a good surgeon you need good hands, but now you also need good feet. (A good brain also helps.)

### PUTTING IT ALL TOGETHER: TECHNIQUE

Technique is a combination of all the elements discussed above, plus the surgeon's own approaches, strategies, and philosophies. Following are a few pointers from my current technique, based on my own experience and preferences.



**Figure 4.** Using a chandelier illumination system and aspirating with the vitreous cutter, it is possible to coagulate vessels that are bleeding.

---

It has always been said that to be a good surgeon you need good hands, but now you also need good feet.

---

**Tip No. 1: Use of a valved cannula system avoids pressure fluctuations.** With steadier pressure, fewer hemorrhages occur (Figure 3). The valved systems also facilitate surgery with fewer instrument exchanges.

**Tip No. 2: Chandelier lighting enhances illumination.** As noted above, I prefer the dual chandeliers because they eliminate shadows and provide broad illumination.

**Tip No. 3: Cut the hyaloid around 360°.** Some surgeons prefer an outside-in approach, others inside-out. My own preference is outside-in, beginning by cutting the hyaloid around 360° at the vitreous base where the retina is thinner. In my opinion, starting from the optic nerve increases the chances of severe hemorrhage.

**Tip No. 4: Use active aspiration and noncontact coagulation with laser.** Chandelier lighting allows a bimanual approach, with the vitreous cutter providing aspiration in 1 hand and the laser in the other. As areas of hemorrhage are identified, the laser is used to coagulate the bleeding (Figure 4). I prefer laser to standard endocautery because it does not thin the retina. Once these areas are coagulated, they will not bleed during the remainder of the surgery.

**Tip No. 5: If possible, no forceps use in diabetic patients.** Once you grasp a membrane, it can be very difficult to

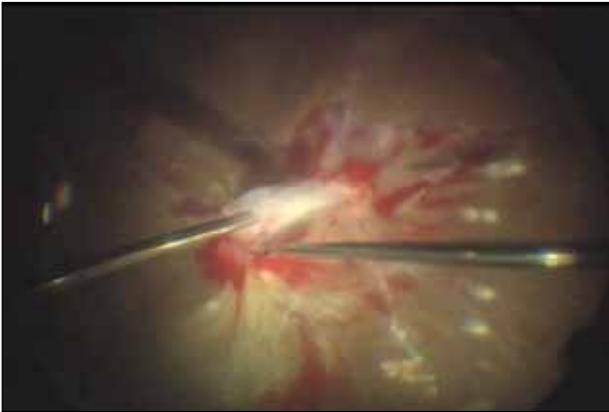


Figure 5. Using the vitreous cutter in aspiration mode instead of forceps minimizes the risk of creating retinal breaks.

release the handle, and excessive traction will create breaks. I prefer to use aspiration on the vitrectomy probe to grasp tissue for separation (Figure 5). With vacuum set at 400 mm Hg on a peristaltic pump, I can decrease the flow to 3 mL/min—very low flow—and this allows me to grasp tissue with the port of the instrument and apply very slow cutting, perhaps 100 cuts per minute. With very low flows and very slow cutting, the procedure is well-controlled. The vitrector acts like a pair of scissors, and the surgeon controls everything going into the port. The dual footpedal is vital for this procedure, controlling the aspiration and the cutting speed.

**Tip No. 6: Do not pull the fibrous proliferation at the optic disc.** If the patient has not been lasered previously, this frequently will start new bleeding. It can be tempting, but it should be avoided. A difficult-to-control hemorrhage at the disc can mean having to close with injection of silicone oil, when this should not have otherwise been necessary.

**Tip No. 7: Use heavy liquids to perform panretinal photocoagulation (PRP).** If clear media permit, I prefer to apply panretinal photocoagulation (PRP) prior to surgery. The reasons for this are simple: The patient needs the laser anyway, and maybe there will be less bleeding and the surgery will go more quickly due to the preoperative PRP. However, if PRP is needed during surgery, I like to inject heavy liquids (Figure 6). The heavy liquids press the retina against the retinal pigment epithelium, facilitating the PRP procedure. After aspiration of the heavy liquids, the retina is checked for breaks, laser is applied to suspicious areas, and the vitreous cavity is filled with air, which will last 4 to 5 days.

## THE ENEMIES

Vitrectomy in diabetic patients is like a war, and the foes to be vanquished are bleeding and retinal breaks.

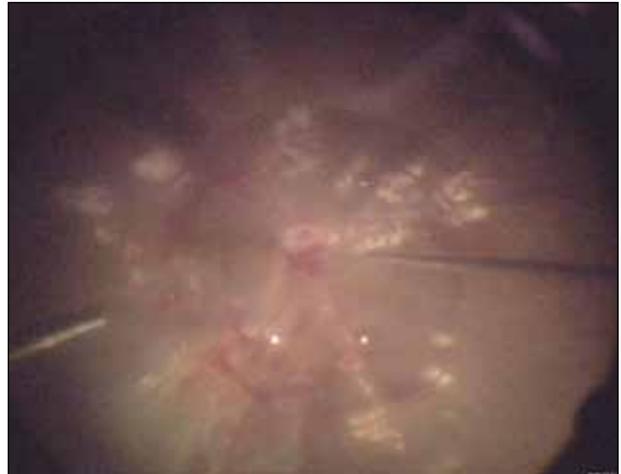


Figure 6. Heavy liquids are injected in order to perform PRP in the areas that are separated because of previous traction.

Preoperative intravitreal injection of bevacizumab and maintenance of steady intraoperative pressure can help to minimize bleeding. To prevent breaks, avoid unnecessary traction and use adequate fluidics.

I always instruct my fellows, in the case of hemorrhage, to stop what they are doing and cauterize the bleed. Do not let it spread, I say; if you do, the bleeding will continue, and visibility will become a problem.

## CONCLUSIONS

Every surgeon has his or her own preferences regarding vitrectomy machine, type of pump, illumination, visualization, and choice of instrument gauge. In most cases, it is not a matter of 1 machine or technique being better or worse than another. As previously noted, the best instrumentation is the one that works best in your hands. Each of us must strive to stay current on instrumentation and pharmacologic advances to determine what are the best choices for our own personal approaches to surgery in complicated diabetic cases. ■

*Virgilio Morales-Canton, MD, practices with the Asociación Para Evitar La Ceguera en México. He states that he has financial relationships with the following companies: Oraya Therapeutics, Bayer, Oertli Instrumente, Sanofi, Clearside Biomedical, and Novartis. Dr. Morales-Canton may be reached at vmoralesc@mac.com.*



1. Machemer R, Buettner H, Norton EW, Parel JM. Vitrectomy: a pars plana approach. *Trans Am Acad Ophthalmol Otolaryngol.* 1971;75(4):813-820.
2. Landers MB, Peyman GA, Wessels IF, Whalen P, Morales V. A new, non-contact wide field viewing system for vitreous surgery. *Am J Ophthalmol.* 2003;136(1):199-201.
3. Chen E, Park CH. Use of intravitreal bevacizumab as a preoperative adjunct for tractional retinal detachment repair in severe proliferative diabetic retinopathy. *Retina.* 2006;26(6):699-700.
4. Oshima Y, Shima C, Wakabayashi T, et al. Microincision vitrectomy surgery and intravitreal bevacizumab as a surgical adjunct to treat diabetic traction retinal detachment. *Ophthalmology.* 2009;116(5):927-938.