

Twenty-seven-gauge Sutureless Microincision Vitrectomy Surgery: A New Frontier?

BY STANISLAO RIZZO, MD; AND FRANCESCO BARCA, MD

Three-port 20-gauge vitrectomy systems have been the gold standard for vitreous surgery since 1974.¹ During the past 30 years, instrumentation has improved significantly. The standard system, which requires conjunctival incisions and sclerotomies of 0.89-mm diameter (20 gauge), has been made smaller and less traumatic. In 2002, a 25-gauge sutureless transconjunctival system was developed and described by Fujii and colleagues.² In 2005, Eckardt introduced a 23-gauge system. Small-gauge vitrectomy with 25- or 23-gauge instrumentation has simplified the vitrectomy procedure and offers numerous potential advantages compared with traditional 20-gauge surgery, including shorter operating time, reduced corneal astigmatism, diminished conjunctival scarring, less postoperative inflammation, improved patient comfort, and, in some cases, earlier visual recovery.³⁻⁵ Moreover, the microcannulas of the system permit interchangeability of instruments between entry sites, protecting the vitreous base from mechanical traction. In 2010, Oshima introduced a new gauge that was even smaller: 27-gauge instrumentation with a diameter of 0.4 mm, which demonstrated excellent surgical results.⁶

The rationale behind 27-gauge surgery is that smaller is better. In this regard, the latest research indicates that smaller-gauge instrumentation and high cutting rates together should theoretically be safer because they increase fluidics stability and potentially minimize vitreous turbulence by allowing only small bits of vitreous to enter the port. Further, high cutting rates also reduce the likelihood of uncut vitreous fibers going through the cutter port, thereby reducing dynamic

Reduced vitreoretinal traction and hypotony and prevention of endophthalmitis are some of the reasons that the concept of 27-gauge PPV is appealing.

vitreoretinal traction with less chance of iatrogenic damage to the retinal surface and reduced incidence of intraoperative retinal tears. The consequence should be less traction on the retinal surface.⁷

Smaller wounds are more likely to self-seal and prevent hypotony. They are also less prone to vitreous prolapse, which may act as a wick and promote endophthalmitis. Reduced vitreoretinal traction and hypotony and prevention of endophthalmitis are some of the reasons that the concept of 27-gauge pars plana vitrectomy (PPV) is appealing.

Using such small instruments, however, means the surgeon must learn to deal with issues such as reduced flow rate and aspiration rate, more flexibility, and reduced endoillumination.

ASPIRATION AND FLOW RATE

Aspiration and flow rate are essential parameters that affect the efficiency and function of the system. They are regulated by Poiseuille's law, which states that flow through a tube is proportional to the fourth power of

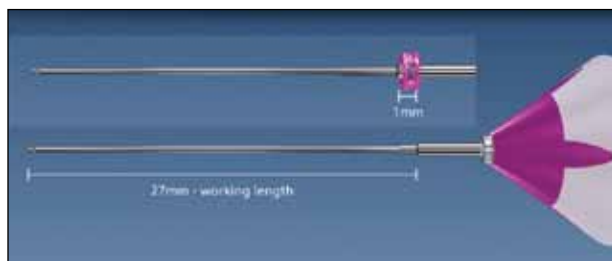


Figure 1. The 27+ cutter.

the radius, and a reduction of internal diameter by 20% theoretically results in a reduction of flow of around 60%. In our experience, the reduction in flow is noticeable, but it can be overcome using higher aspiration and the Constellation's (Alcon) Proportional Vacuum System. In fact, using a high-speed vitrector, the vitreous is cut into small pieces, and an effective flow rate can be achieved because the probe is not obstructed by the vitreous fragments. We set the machine with an initial aspiration of 200 mm Hg and move linearly to 650 mm Hg when the foot-pedal is fully depressed, maintaining a fixed cut rate of 7500 cpm. In this way, we have a maximum aspiration and flow cut rate during core vitrectomy, and, vice versa, a minimum aspiration and flow during vitreous shaving when lower traction on the vitreoretinal surface is required.

RIGIDITY

Rigidity of instrumentation is dependent on its material, thickness, diameter (gauge), and length. In 2004, Alcon introduced the 25+ product line, which incorporates several advances, including increased rigidity compared with standard 25-gauge instrumentation.

One of the potential drawbacks of 27-gauge instrumentation is its increased flexibility. To minimize the flexibility, Oshima et al⁶ shortened the shaft of their vitrector from 32 mm (ie, Alcon's 25-gauge shaft length) to 25 mm. In doing so, they produced a 27-gauge vitrector with similar stiffness to the standard 25-gauge vitrector. The authors contend that, even with a shorter shaft length, they were able to perform core and peripheral PPV in eyes with axial lengths ranging from 22 to 28 mm. Alcon designed its 27+ vitrector with the same length as the current 25+ and tapered the stiffening sleeve that enters the cannula and provides maximum working length and stiffness (Figure 1). In this way, Alcon achieved a higher degree of stiffness than standard 25 gauge, although not as stiff as the 25+.

ILLUMINATION

When the 25-gauge system was first introduced, 1 of the early drawbacks was that the illumination using hal-



Figure 2. The 27+ light pipe, cutter, and trocar.

ogen lighting was not nearly as bright as in conventional 20-gauge PPV. Currently, with the new-generation xenon and mercury vapor illumination sources, illumination inside the vitreous cavity has greatly improved and, to date, fills the eye without any problems.

Reducing the diameter of a light pipe, however, even by another 20% theoretically reduces the amount of illumination by approximately 35%. This is not a concern because current-generation illumination sources fill the eye with light equally and properly. For example, the BrightStar illumination system (Dutch Ophthalmic) and the Synergetics 30-gauge chandelier light fibers provide excellent illumination. The Constellation and Stellaris PC (Bausch + Lomb) have excellent illumination technology, both of which should be able to be used with 27-gauge instrumentation.

In their recent study, Oshima et al⁶ designed a short-shaft light pipe. This light pipe is 13 mm in length and sharp enough to enter the eye using a stab incision. According to the authors, the light pipe gives off 20 lm of light with a xenon light source and 25 lm with a mercury vapor light source, enough to perform most tasks in vitreoretinal surgery. Based on this design, Alcon has designed a 27+ light pipe with the same length as the 25+ light pipe (Figure 2).

WOUND CONSTRUCTION

Possibly the most significant advantage of 27-gauge instrumentation is the possibility of creating a simple incision without any leakage after cannula removal. The most serious criticisms regarding the current 23- and 25-gauge systems are related to wound sealing, such as leakage, hypotony and postoperative infectious endophthalmitis. Although the recent refinement of trocar-cannula systems has ergonomically improved their self-sealing architectures, special techniques are still required. By using the 27-gauge system, opening and closing procedures are simplified, and surgeons can begin vitrectomy immediately after creating scler-

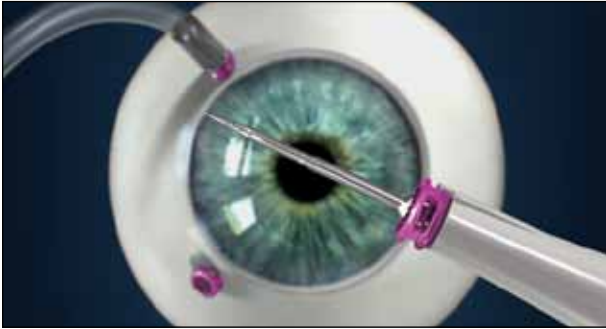


Figure 3. The 27+ trocar cannula.



Figure 5. Retinal detachment surgery using 27+.

rotomies with 1-step insertion. Simplified opening and closing procedures also translate into shorter total operating time because sutures are not required after cannula removal, even in cases with thin scleras or multiple surgeries. The EdgePlus Entry System (Alcon) has a proprietary blade edge and cylinder ridge to create a flat, linear incision. Valved cannulas are designed for quick and easy insertion and are easily removed from the trocars after insertion without a second instrument (Figure 3).

In our experience, we have used 27+ instrumentation to carry out a simple 1-step incision at a 30° angle, a technique that has allowed us to achieve a perfect wound closure both with balanced salt solution and air.

INSTRUMENTATION

Over the past several years, major advances in instrumentation have occurred, and it is now possible to perform nearly all types of vitreoretinal surgery using micro-incision techniques. In their recent study, Oshima et al⁶ developed several instruments for 27-gauge PPV. These instruments include a vitrector, 1-step infusion line, 1-step short-shaft light pipe, several forceps (asymmetric, end-gripping, and pick forceps), membrane spatula, blunt-tip and sharp-tip endolaser probe, microvertical



Figure 4. The 27+ portfolio (Alcon Laboratories, Inc.).

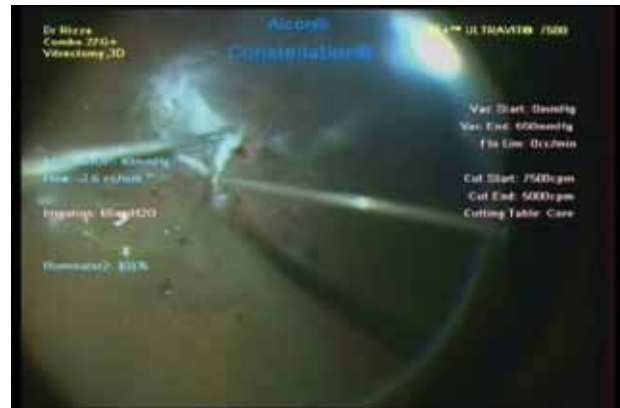


Figure 6. Diabetic tractional retinal detachment surgery using 27+ instrumentation.

scissors, sharp-point vertical scissors, and a trocar cannula system. Using these instruments, they were able to perform several surgeries safely and effectively.

The Alcon 27+ product portfolio is complete and available both in a 27+ vitrectomy pack and combined procedure pack. The stiffness experience is similar to 25+. The 27+ vitrectomy probe, featuring dual-pneumatic driven technology, has the ability to achieve 7500 cpm and has been produced to minimize flexibility. The 27+ accessories currently include internal limiting membrane forceps, end-grasping forceps, Maxgrip forceps, straight scissors, diathermy probe, flexible-tip laser probe, high-flow backflush, and soft tip (Figure 4). All of these instruments utilize a stiffening sleeve on the shaft for improved control and rigidity.

POTENTIAL INDICATIONS

As with 25-gauge instrumentation, when the 27-gauge system first became available, we used these instruments for simpler cases such as macular holes, macular puckers, or simple vitreous hemorrhages. Twenty-three or 25 gauge was still preferred for complex cases. Oshima et al⁶ also used 27-gauge for relatively uncomplicated indications.

To date, our experience has improved, and we have

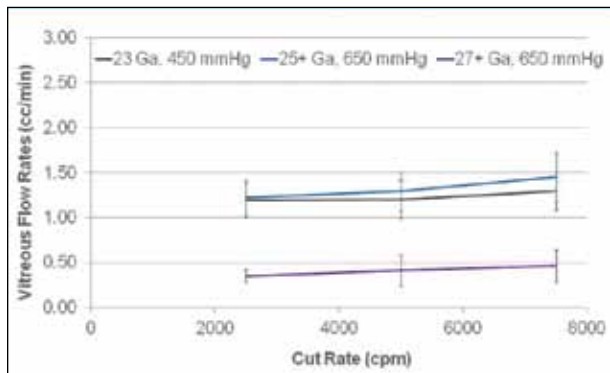


Figure 7. Vitreous flow rate data with 27+.

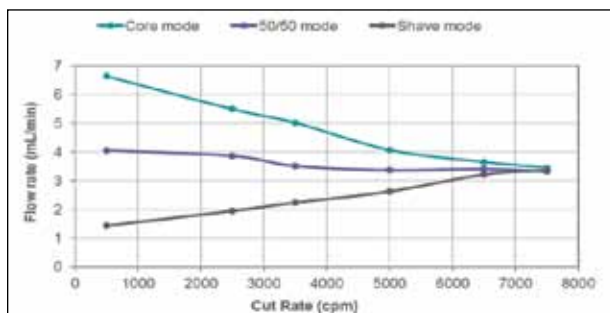


Figure 8. Duty cycle control using 27+, 7500 cpm, balanced salt solution flow rate, and 650 mm Hg vacuum.

begun to use 27+ gauge for more complex cases such as rhegmatogenous retinal detachment (Figure 5) and proliferative diabetic retinopathy. In fact, as with 25+, the port size on 27+ and its distance from the end of the cutter are important considerations when evaluating a vitrector. Compared with the 25+ probe, the 27+ probe has the same length and diameter, smaller port area, and the same distance from the port to the tip. Having a smaller port and a proximity closer to the tip may be advantageous when performing complex maneuvers, such as membrane segmentation or delamination, because it can be more easily inserted into the tiny space between the membrane and the retina (Figure 6).

CONCLUSIONS

To date, the highest expression of vitrectomy is achieved by systems capable of achieving a cut rate up to 7500 cpm, and is, for this reason commonly called *ultrahigh-speed vitrectomy*. Ultrahigh-speed vitrectomy has the theoretical advantage of potentially reducing the number of intraoperative retinal breaks, minimizing vitreous turbulence, and reducing dynamic vitreoretinal traction.⁷

The Constellation Vision System has a series of new technological features in the panorama of vitreoretinal surgery, which are designed to optimize performance

Weigh in on this topic now!



Direct link: <https://www.research.net/s/RT14>

What is your primary concern associated with 27-gauge vitrectomy?

- ☐ Reduced flow and aspiration
- ☐ Reduced endoillumination
- ☐ Increased flexibility of instruments
- ☐ Limited availability of instruments
- ☐ None of the above
- ☐ I have no concerns

and surgical safety while reducing possible complications. The latest innovation is the association between ultrahigh-speed vitrectomy and the 27+ probe (Figure 7).⁸ Using a high-speed vitrector produces an effective flow rate because the vitreous is cut into small pieces that do not obstruct the probe. Furthermore, Ray et al⁹ have shown that using the duty cycle on the Constellation allows high flow rates even when using high cut rates (Figure 8).

The new-generation 27+ vitreous cutter may provide a new paradigm for high-flow and smaller-diameter instrumentation, thus increasing the efficiency of the small-gauge technique as well as the safety of surgery. ■

Stanislao Rizzo, MD, is Director of U.O. Chirurgia Oftalmica, Ospedale Cisanello, Azienda Ospedaliero Universitaria Pisana in Pisa, Italy. Dr. Rizzo is a member of the Retina Today Editorial Board. He may be reached via email at stanislao.rizzo@gmail.com.



Francesco Barca, MD, is a vitreoretinal surgery fellow at the Academic Medical Centre, University of Amsterdam, the Netherlands.

- O'Malley C, Heintz RM Sr. Vitrectomy with an alternative instrument system. *Ann Ophthalmol*. 1975;7:585-588, 591-594.
- Fujii GY, De Juan E Jr, Humayun MS, et al. Initial experience using the transconjunctival sutureless vitrectomy system for vitreoretinal surgery. *Ophthalmology*. 2002;109:1814-1820.
- Recchia FM, Scott IU, Brown GC, et al. Small-gauge pars plana vitrectomy: a report by the American Academy of Ophthalmology. *Ophthalmology*. 2010;117:1851-1857.
- Kadonosono K, Yamakawa T, Uchio E, et al. Comparison of visual function after epiretinal membrane removal by 20-gauge and 25-gauge vitrectomy. *Am J Ophthalmol*. 2006;142:513-515.
- Rizzo S, Genovesi-Ebert F, Murni S, et al. 25-gauge, sutureless vitrectomy and standard 20-gauge pars plana vitrectomy in idiopathic epiretinal membrane surgery: a comparative pilot study. *Graefes Arch Clin Exp Ophthalmol*. 2006;244:472-479.
- Oshima Y, Wakabayashi T, Sato T, et al. A 27-gauge instrument system for transconjunctival sutureless microincision vitrectomy surgery. *Ophthalmology*. 2010;117:93-102.
- Charles S. An engineering approach to vitreoretinal surgery. *Retina*. 2004;24:435-444.
- Abulon DJK, Buboltz DC. Porcine vitreous flow behavior during high speed vitrectomy up to 7500 cuts per minute. Paper presented at: the Association for Research in Vision and Ophthalmology Annual Meeting; May 2012; Fort Lauderdale, FL.
- Ray A, Abulon JK, Dimalanta R et al. Intraocular pressure and BSS flow rates at high vitrectomy probe cut rate. Paper presented at: the Association for Research in Vision and Ophthalmology Annual Meeting; May 2012; Fort Lauderdale, FL.