

THE 27-GAUGE REVOLUTION

The trend toward smaller surgical instruments has led most recently to the creation of 27-gauge surgery. But is it the be-all and end-all?

BY MICHAEL A. KLUFAS, MD, AND JASON HSU, MD



The smallest commercially available instrumentation for pars plana vitrectomy (PPV) is 27 gauge.^{1,2} An increasing number of clinical series have been published on its use,³⁻⁵ even in complex cases such as proliferative vitreoretinopathy

(PVR) requiring silicone oil placement.⁶ Since initial feasibility and safety studies were published in 2010,² an ever-increasing amount of data is available for retina specialists to evaluate this exciting new evolution in vitreoretinal surgery.

In the United States, 27-gauge vitrectomy packs are available for the Eva vitrectomy system (Dutch Ophthalmic USA) and the Constellation Vision System (Alcon). Bausch + Lomb is developing a 27-gauge platform for its Stellaris PC Vision Enhancement System, which it plans to roll out in the first half of 2017. Interested readers can learn more about these vitrectomy systems at bit.ly/vitsystems. This article examines 27-gauge systems and instruments and their applications in vitreoretinal surgery.

PROS AND CONS OF VITRECTOMY GAUGES

Since the introduction of 25-gauge vitrectomy by de Juan and colleagues⁷ more than a decade ago, the dogma of “smaller is better” has been reflected in the rise of microincisional vitrectomy and the near extinction of

“ Similar to the evolution of 25-gauge vitrectomy, it is likely that further enhancements in 27-gauge instrument design will be forthcoming.

20-gauge vitrectomy. It is important to remember that the shortcomings of the initial 25-gauge vitrectomy platforms, such as increased vitrectomy times and excessive instrument flexibility, led to the development and use of 23-gauge vitrectomy systems,⁸ raising the question of whether smaller really is better.

A primary criticism of 23- and 25-gauge vitrectomy is that sclerotomies performed with systems in these gauges do not seal completely, which can lead to hypotony, choroidal detachment, and endophthalmitis. Decreasing the gauge size to 27 gauge (0.4 mm) has the potential to decrease the rate of these complications.¹ However, initial clinical series show that, even with 27-gauge incisions, suturing of sclerotomies may be necessary and hypotony is still possible.³ In vitro studies with human cadaveric eyes have suggested that non-beveled 27-gauge incisions are less likely to allow bacteria to enter the eye compared with 23-gauge nonbeveled sclerotomy incisions.⁹ A prospective study comparing 25-gauge versus 27-gauge vitrectomy evaluated sclerotomy incision via anterior segment optical coherence tomography (OCT) and found no difference in the mean time to scleral wound closure (8.6 vs 7.7 weeks).¹⁰

There is no way around it: it will take longer to remove the vitreous with smaller 27-gauge instrumentation than with 23- or 25-gauge cutters. One of the key metrics of vitrectomy efficiency is flow rate, which is proportional to aspiration force, the fourth power of the radius, cut rate, and duty cycle; and inversely proportional to cutter length and the viscosity of the medium being removed.^{1,11-13} Oshima and colleagues have reported that the 27+ vitrectomy cutter (Alcon) showed approximately 60% the efficiency of the 25+ vitreous cutter (Alcon) at 7,500 cuts per minute (cpm).¹ A clinical



AT A GLANCE

- A primary criticism of 23- and 25-gauge vitrectomy is that sclerotomies performed with systems in these gauges do not seal completely, which can lead to hypotony and increased risk of endophthalmitis.
- Use of 27-gauge surgery has been described for even the most complex vitreoretinal surgical procedures; however, there is a learning curve.
- New platforms and further enhancements to instrument design and efficiency will be needed to foster increased adoption of 27-gauge surgery.

study with the Eva TDC cutter (Dutch Ophthalmic USA) found that mean core vitrectomy time was 73.80 seconds for 25 gauge and 159.71 seconds for 27 gauge.¹¹ The same core vitrectomy with a standard non-TDC Dutch Ophthalmic USA 27-gauge vitreous cutter was 242.71 seconds.¹¹

Despite these increased times, the fluidics of vitreous cutters are noteworthy. The Eva 27-gauge TDC cutter is capable of removing half of a nucleus from the posterior segment without the need for a traditional fragmatome.¹⁴ In fact, the aspiration of that 27-gauge cutter is equal to or greater than that of a standard non-TDC 25-gauge cutter.

The rigidity of 27-gauge instrumentation may be superior to that of early 25-gauge systems, but it is still noticeably more flexible than that of newer 25-gauge instrumentation. This flexibility may present a learning curve for surgeons accustomed to using the shaft of the cutter to translate or tilt the eye, and it may present a challenge in addressing very anterior pathology. On the other hand, the smaller tip size may be beneficial during dissection of membranes, allowing the cutter to act as a membrane pick or to take on characteristics of a malleable soft tip.¹ One group has reported that it is possible to peel epiretinal membranes (ERMs) using a 27-gauge cutter without forceps due to the smaller port opening and low sphere of influence (high suction at the ostium of the cutter that rapidly decreases).^{15,16}

Additionally, the tips of 27-gauge forceps are smaller than those of 23- and 25-gauge instruments, which actually have the same size tips despite the difference in gauge. This has led some surgeons to comment that internal limiting membrane (ILM) peeling with 27-gauge forceps has a tendency to lead to more shredding of tissue compared with 23- and 25-gauge forceps tips.

BEST PAIRINGS FOR 27-GAUGE

An increasing number of studies suggests that even the most complex cases can be performed with 27-gauge platforms.^{4,6,14,17,18} But which cases are ideal for these small-gauge platforms?

Vitrectomized Eyes

Anecdotal reports indicate that there is great value in the use of 27-gauge vitrectomy in eyes that have previously undergone vitrectomy, as the speed of core vitrectomy and the removal of peripheral vitreous is not a factor. Furthermore, the smaller incisions may produce less conjunctival scarring, resulting in decreased postoperative inflammation, and they may seal more frequently than larger-gauge incisions, obviating the need for suturing.

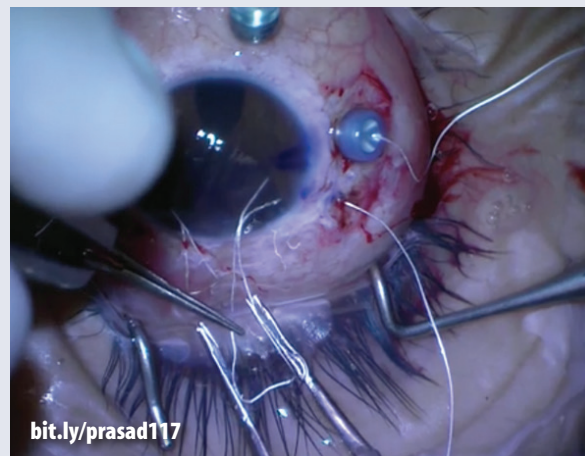
Secondary IOL Fixation

In the fixation of a secondary intraocular lens (IOL) with PTFE Gore-Tex suture, 27-gauge surgery may result in less postoperative hypotony than 23- or 25-gauge vitrectomy,

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Video 1. 27-Gauge Scleral Fixation of IOL With Gore-Tex Suture

Michael A. Klufas, MD, and Pradeep S. Prasad, MD, use the Eva vitrectomy system to fixate an IOL to the sclera with PTFE Gore-Tex suture.



and there may be a decreased risk of inadvertently damaging the PTFE suture if a sclerotomy must be closed because of leakage (Video 1).¹⁹ Direct fixation of a three-piece IOL haptic to the sclera may also benefit from the smaller scleral tunnels created with 27-gauge instruments, particularly in patients with thin sclera such as those with pathologic myopia or Marfan syndrome.²⁰

Macular Hole Repair

Although removal of the vitreous takes longer with 27-gauge surgery, the benefits of a sutureless, nonleaking incision may allow a more consistent, complete gas fill and may potentially decrease the need for facedown positioning. Future clinical studies are needed to further investigate the potential benefits of 27-gauge surgery in macular hole repair.

Oncology

In ocular oncology, molecular prognostication in uveal melanoma is increasingly popular and considered by some to be standard of care.²¹⁻²³ Studies have indicated that the 27-gauge cutter can be used in a two-port or three-port vitrectomy to obtain tissue samples in uveal melanomas—even those less than 2 mm in height.²⁴

Diabetic Surgery

For segmenting and delaminating tightly adherent fibrovascular membranes, the smaller sized 27-gauge cutter may

be advantageous. Several groups have now reported on the use of hybrid vitrectomy—using mixed gauges in one surgical episode—for diabetic tractional detachments and retinopathy of prematurity.^{18,25,26} The use of 23- or 25-gauge vitrectomy packs will still allow the introduction of a 27-gauge cutter for the benefit of its maneuverability and unique fluidics without compromising the use of other instrumentation,

such as curved scissors or forceps that are not available in 27 gauge. With the Constellation Vision System, a 27-gauge cutter may be opened by itself in addition to the standard 23- or 25-gauge vitrectomy pack and then used as the primary vitreous cutter through the 23- or 25-gauge cannula. A more cost-effective option is to open a 27-gauge pack and also use standalone 23- or 25-gauge cannulas. Dutch Ophthalmic USA

Instrumentation for Pediatric Vitrectomy



By Aaron Nagiel, MD, PhD

Vitreoretinal surgery in pediatric patients has its own set of considerations that play into choice of instrumentation. First, eyes in this patient population are smaller, and the width of the pars plana is decreased to varying degrees. This means the lens occupies a greater fraction of the vitreous cavity, and the

vitrectomy ports are closer to the lens. Second, the vitreous tends to be formed and more adherent to the retina. Third, much of the pathology in pediatric eyes is located anteriorly.¹

Specialized instruments have been developed to address some of these issues. Several surgical companies offer “short” versions of their vitrectomy packs, which include smaller light pipes, cutters, trocars, and cannulas. Theoretically, with shorter cannulas there should be a diminished risk of touching the lens and increased access to the anterior vitreous.

There has also been an effort to develop small-gauge vitrectomy systems for pediatric patients. Alcon offers 25+ Short products, including a 25+ Short UltraVit Vitrectomy Probe and a 25+ Short Endoilluminator. Dutch Ophthalmic USA is developing a 27-gauge short platform that should be commercially available soon.

Because instrument rigidity is beneficial when dealing with formed pediatric vitreous, it remains to be seen how useful small-gauge instruments will be in this setting. Also, sclerotomies performed in young children should be sutured closed, so the benefits of self-sealing wounds may not be realized in the pediatric population.²

The use of endoscopy has been championed by some pediatric retina surgeons³ because the probe’s coaxial light source provides better illumination of the vitreous and because it enables improved access to anterior structures that are difficult to visualize with a top-down system. Most surgeons use a 20-gauge straight probe (Endo Optiks), but smaller-gauge versions are in development. Alcon is testing an endoscopic system that will work with the NGenuity 3D Visualization System that the company is developing in collaboration with TrueVision 3D Surgical.



(Image courtesy of Thomas C. Lee, MD)

Intraoperative image obtained with 20-gauge endoscope showing the cutter tip addressing vitreous traction immediately adjacent to the crystalline lens. This was a stage 4A detachment in a 42-week-old infant born at 24 weeks.

We are in a favorable environment for pediatric vitreous surgery, with an expanding surgical toolset that is customized to the specific needs of pediatric vitreoretinal pathology. Future developments such as high-resolution, small-gauge endoscopic platforms could have the potential to further revolutionize the field.

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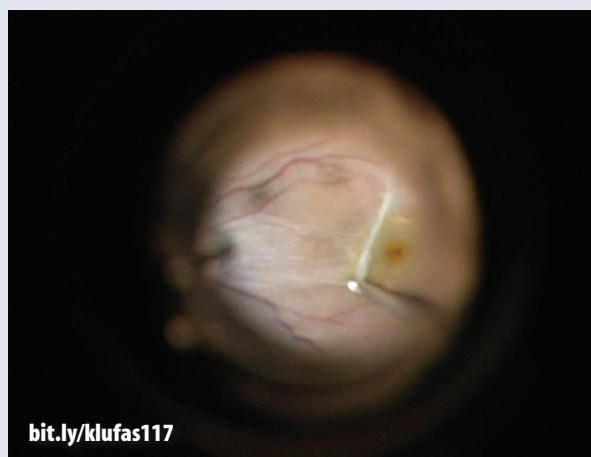
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Video 2. 27-Gauge PPV With Membrane Peel

During this 6-minute procedure by Michael A. Klufas, MD, and Steven D. Schwartz, MD, ILM forceps were inserted through a 27-gauge trocar and were used to remove a macular pucker in a 48-year-old man with progressively decreasing vision and metamorphopsia after silicone oil removal and cataract extraction with IOL placement.



offers the option to produce custom vitrectomy packs that contain a 23-gauge infusion cannula with the other cannulas and cutter of smaller gauge.

The following example illustrates an ideal case for 27-gauge PPV.

CASE EXAMPLE

A 48-year-old man who had previously undergone scleral buckle band, vitrectomy, membrane peeling, and silicone oil tamponade for a rhegmatogenous retinal detachment with PVR presented with progressively decreasing vision (BCVA 20/100) and metamorphopsia in the right eye. Spectral-domain OCT revealed a dense ERM with distortion of the foveal contour.

PPV with membrane peel was performed with 27-gauge instrumentation to take advantage of the small incision size. (There was no need to remove vitreous gel because the patient had already undergone vitrectomy.) Three 27-gauge trocar-cannulas were placed in an oblique, beveled fashion, and ILM forceps were used to remove the macular pucker. A partial air-fluid exchange was performed at the conclusion of the case, and the sclerotomies were found to be airtight. The total time from placement of the three ports to removal of the operative drape was less than

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Video 3. In-Office Air-Fluid Exchange

In this video, Calvin E. Mein, MD, inserts a 25-gauge nonvalved trocar and then uses a bent 30-gauge needle to inject air into the eye of a patient with diabetic vitreous hemorrhage following vitrectomy.



6 minutes (Video 2). The patient noted improvement of visual acuity to 20/70 on the first postoperative day despite the partial air fill, and he reported minimal discomfort compared with his prior procedures.

DISCUSSION

This case exemplifies a remarkably efficient scenario for 27-gauge vitrectomy. In fact, with careful patient selection, in-office vitrectomy procedures with 27-gauge instrumentation may be part of the future. Surgeons have used 25-gauge instrumentation for in-office air-fluid exchange in cases of persistent vitreous hemorrhage after diabetic vitrectomy (Video 3) or vitreous tap-and-inject procedures in endophthalmitis.²⁷ Given the smaller incision size and lower likelihood of wound leak, 27-gauge instrumentation may offer greater advantages for these types of office-based intraocular procedures.

FUTURE DIRECTIONS

Since the initial development of PPV, instrumentation has progressively become smaller, and 27-gauge instrumentation is now the smallest commercially available for vitreoretinal procedures. The use of 27-gauge instrumentation has been reported for even the most complex vitreoretinal surgical procedures. However, disadvantages of this smaller instrumentation, including increased time to remove vitreous gel, are still not completely overcome by ever-increasing cut rates and higher aspiration. Newer vitrectomy platforms that include an ultrasonic cutter may mitigate these fluidics shortcomings.

Similar to the evolution of 25-gauge vitrectomy, it is likely that further enhancements in 27-gauge instrument design will be . In particular, improving instrument stiffness through a combination of novel designs and materials will be necessary to promote greater interest in 27-gauge surgery. Additional enhancements to cutter designs, with faster cut

speeds and increased aspiration, will likely improve efficiency in 27-gauge vitrectomy. ■

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