In this issue’s Practical Retina column, Sundeep K. Kasi, MD, and Jason Hsu, MD, from the Retina Service at the Wills Eye Institute, discuss the current role of 27-gauge vitrectomy in managing various vitreoretinal disorders and compare this new platform to traditional vitrectomy approaches.

We are all aware that there is great discussion and wide variability in thinking among our colleagues regarding the 27-gauge approach for vitrectomy surgery. Common controversies include: in which cases a smaller-gauge approach is necessary, the differences in case time using the various platforms, and how to manage overly flexible 27-gauge instruments. Drs. Kasi and Hsu tackle this topic in a concise and logical manner, focusing first on basic science research about infection risk, tips on getting started with 27-gauge vitrectomy, and the differences between various 27-gauge vitrectomy options. Throughout their article, they also discuss the pros and cons of this new technology relative to our more frequently used platforms.

I am certain that their insights will be very valuable for maximizing surgical outcomes in patients affected by the various vitreoretinal disorders.

Making the Jump to 27-Gauge Vitrectomy: Perspectives

by Sundeep K. Kasi, MD, and Jason Hsu, MD

Adopting new technology can sometimes be a challenge. We become accustomed to what works for us and may be reluctant to venture into unknown territory. Although “new” does not always equate with “better,” we often grow as clinicians and surgeons when we step outside of our comfort zone in order to sample that next-generation, “latest and greatest” development. In this article, we discuss the differences, advantages, and unique benefits of 27-gauge systems compared with larger-gauge systems for vitrectomy surgery.

**IS 27-GAUGE REALLY ALL THAT IT’S CRACKED UP TO BE?**

The key advantages of 27-gauge vitrectomy include a reduced “sphere of influence,” greater ability to maneuver into tight spaces, and a reduced sclerotomy size. Sphere of influence describes the volume within which fluid and tissue movement occurs due to the aspiration and cutting of the vitreous cutter port. A smaller sphere of influence allows the vitreous cutter to safely approach retinal tissue without damaging it. This allows for more precise removal of vitreous during peripheral shaving and, more importantly, removal of preretinal membranes with greater control and less tractional forces compared to scissors or illuminated pick and forceps for bimanual dissection.

The smaller size of the cutter, along with displacement of the mouth toward the tip, allows greater maneuverability and manipulation into tight spaces. Nowhere is this more evident than in diabetic traction retinal detachments (TRDs). The 27-gauge size is ideal for sneaking between the membranes and retina to find a dissection plane, similar to a pick (Figure 1). At the same time, though, the cutter can be engaged to create a scissor-like action for segmenting and delaminating membranes. With this technique, the membranes can be more precisely manipulated with far less traction on the underlying retina, making the risk of iatrogenic breaks much lower.

There are multiple downstream advantages of a smaller sclerotomy size. The first is that a smaller sclerotomy is...
much less likely to leak after cannula removal.\textsuperscript{4,6} This results in reduced need for suture closure of sclerotomies, which may reduce operating time, cost, and postoperative discomfort. Second, water-tight closure of the sclerotomies results in less postoperative hypotony due to wound leaks, which is a risk factor for endophthalmitis.\textsuperscript{4,6} A cadaveric model of various gauge incisions and closure revealed high concentrations of bacteria in postvitrectomy samples for sutureless 23-gauge perpendicular incisions, but no bacteria in any 27-gauge incision regardless of angled or perpendicular placement and closure.\textsuperscript{7} More recently, we published a study comparing angled versus perpendicular cannula insertion in 27-gauge and found a transiently lower postoperative day 1 intraocular pressure in eyes with perpendicular placement, suggesting that an angled approach may still be preferred to lower the risk of wound leak, hypotony, and possibly endophthalmitis.\textsuperscript{8} However, although the incidence of endophthalmitis in 27-gauge vitrectomy has not been reported yet, one case report of endophthalmitis after 27-gauge surgery exists.\textsuperscript{9}

\textbf{GETTING STARTED WITH 27 GAUGE}

For those who had the unique privilege of working with the first-generation 25-gauge instrumentation on the Accurus 400 platform (Alcon, Fort Worth, TX), the transition to 27-gauge instrumentation will be a piece of cake, since all the wonderful memories of overly flexible instruments and increased vitrectomy time will come flooding back. For those who missed that exciting time, there is certainly a learning curve with 27-gauge.

The first thing to realize is that the instruments cannot tilt and torque the eye as well as 23- and 25-gauge instruments. We typically try to avoid moving the eye around with the 27-gauge instruments, but rather keep the eye in primary position and pivot our instruments around the cannulas to reach the periphery. If it becomes necessary to tilt or torque the eye, placing the index finger on the shaft of the instrument can help increase the apparent stiffness.

It is also important to recognize that 27-gauge vitrectomy is going to take longer than larger-gauge surgery, simply due to the fluidics. We are using a much smaller “straw” to suck out the same volume

\textbf{Figure 1.} The 27-gauge cutter can be used as a single instrument to dissect, engage, and remove fibrovascular membranes in a severe diabetic traction retinal detachment.
of fluid. In addition, due to the decreased sphere of influence, the cutter really needs to be brought to the gel in order to efficiently complete the vitrectomy. With the Constellation system (Alcon, Fort Worth, TX), we have generally found that the three-dimensional vitrectomy mode seems more efficient than proportional mode with a fixed high cut rate.

A good initial case to get the feel of the instruments might be a vitrectomy for vitreous hemorrhage (without much active underlying pathology) or floaters. Once comfortable with the cutter, a diabetic TRD is actually a great case to see how well 27-gauge can work. When moving on to macular cases, such as macular puckers and holes, there is an additional learning curve with use of the 27-gauge forceps. One criticism has been the tendency for delicate membranes, such as the internal limiting membrane, to shred more easily due to the smaller surface area of the 27-gauge forceps platform. Newer forceps have been designed with wider tips and larger grasping areas that may minimize this issue. Another alternative is to use the 27-gauge cutter itself to engage membranes and perform the peel (Figure 2). In these situations, we typically create a flap in the membrane then use the cutter with the mouth facing up to go between the membrane flap and underlying retina. Suction is then engaged to grab the membrane and complete the peel. With this technique, there tends to be much less tissue shredding.

**IS A CUTTER BY ANY OTHER NAME STILL A CUTTER?**

The two major platforms for 27-gauge vitrectomy are the Constellation and the EVA (Dutch Ophthalmic Research Center [DORC], Zuidland, The Netherlands). Alcon’s 27-gauge cutter is designed like its 23- and

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**Figure 2.** The 27-gauge cutter may be used to strip the internal limiting membrane (ILM) using existing ILM flap, as the ILM forceps tend to shred the ILM when grasping.
25-gauge counterparts. The length of the instrument is the same and the distance from the tip of the instrument to the cutter opening is equal. It uses pneumatic oscillation to achieve 7,500 cuts per minute (cpm).

The DORC EVA system introduced the concept of twin duty cycle, also referred to as two-dimensional cutting (TDC). The TDC cutter design allows for the pneumatic oscillation to cut both as the inner needle moves forward past the cutter opening and again upon returning past the cutter opening (Figure 3). Utilizing this design, the DORC TDC cutter can achieve 16,000 cpm with a 92% open duty cycle providing minimal disruption to aspiration. An in vitro assessment of the TDC cutter compared with standard cutters showed that flow rate was maintained with the TDC cutter as cutting frequency increased, whereas flow rates were decreased with higher cutting frequency in standard cutters. This maintains vitrectomy efficiency at a high cut rate, but nonetheless the overall flow rate of a 27-gauge instrument still increases the overall time for complete vitrectomy. In our experience, the 27-gauge TDC cutter is remarkably more efficient than a standard 27-gauge cutter and even seems to rival the time for core vitrectomy with a standard 25-gauge cutter. The TDC cutter is also available in the 23- and 25-gauge systems.

Figure 3. The DORC two-dimensional cutting system utilizes a unique inner needle with two openings, allowing essentially continuous flow and two cutting motions with each oscillation of the pneumatic cutter.
SO, WHY IS 27-GAUGE NOT FLYING OFF THE SHELF?

This is likely due to some of the perceived and real disadvantages of 27-gauge vitrectomy, including longer vitrectomy time, reduced instrument rigidity, and fewer available instruments. A number of studies have shown that the time to complete vitrectomy using 27-gauge instruments is longer than their 25- and 23-gauge counterparts.\(^{11-13}\) Although the TDC cutter certainly increases the efficiency quite noticeably with 27-gauge vitrectomy, there is inherently going to be a longer vitrectomy time due to the smaller diameter lumen. Given Pouiseille’s Law, we know that the flow of fluids is directly related to the fourth power of the radius and, therefore, even small decreases in the lumen size significantly affects flow. Similarly, the smaller sphere of influence that results means that the surgeon must bring the cutter to the vitreous rather than expect the vitreous to come to the cutter.

The flexibility of 27-gauge instruments is another hurdle to its adoption. In the beginning, it is not uncommon to see bent instruments during a case, sometimes even due to just sticking the instruments into the side pockets. In many ways, this is similar to what early adopters of the original Alcon 25-gauge vitrectomy systems\(^ {14}\) dealt with. Some adjustments to 27-gauge systems have been developed including a shorter cutter length, producing similar rigidity to the 25-gauge system, or through the use of a stiffening sleeve in the cutter design.\(^ {4}\) Nonetheless, the preference for stiffer instruments, which previously led to the development of 23-gauge vitrectomy systems\(^ {15}\) and later improvements in stiffness to the 25-gauge systems, will likely hamper the adoption of 27-gauge until further refinements are made.

Although increasingly more instruments are becoming available in 27-gauge, there are still some key ones missing, such as an illuminated...
endolaser probe, though we expect that this will be available in the near future. Injecting and removing oil through the 27-gauge system is also currently difficult and more time-consuming than with larger-gauge systems, although the DORC EVA system does accommodate this with a high-flow tubing that fits over the cannula. Silicone oil tamponade can be performed with good outcomes on the Alcon platform using the 25-gauge oil infusion cannula, with back pressure holding the 27-gauge cannula against the oil cannula with forceps.16

In an ideal world, most surgeons and operating rooms would prefer one standard system to suit all cases, as having different gauge systems requires a line-up of instruments suited for that particular gauge. This is the crux of the challenge that 27-gauge faces as it currently is not yet an ideal system for all cases. For example, we currently do not prefer to use 27-gauge for repair of rhegmatogenous retinal detachments. Peripheral shaving in this situation is more time-consuming and is more likely to require scleral depression by a skilled assistant due to reduced rigidity of the instruments.17 Second, laser barricade of anterior breaks may similarly require scleral depression or a chandelier light source depending on the relationship of the break to the sclerotomy sites since there is no illuminated endolaser option.

WHAT’S NEXT?

We expect that incremental design modifications and a greater array of available instruments will lead to wider adoption of 27-gauge instrumentation. For example, a beveled tip for the 27-gauge cutter (as well as its 23- and 25-gauge counterparts) has been designed by Alcon that will allow the cutter to sit closer to the retina with a higher cut rate of 10,000 cpm, theoretically permitting greater ease of membrane dissection with less risk of retinal injury (Figure 4). Stronger materials and novel instrument designs will be needed to decrease instrument flexibility. Improvements to fluidics will also be necessary to improve efficiency, such as increasing vacuum and/or decreasing the viscosity of the vitreous through either greater cut speeds or alternative technologies. One interesting concept is the idea of ultrasonic vitrectomy, which may be able to more quickly liquefy vitreous than a mechanical cutter.18-20

Despite some of the current downsides, there is no question that 27-gauge vitrectomy can be successfully used in all types of cases, including vitreous opacities, macular cases, retinal detachment repair, traction retinal detachment repair, scleral-fixated intraocular lenses (Figure 5), and even retained nuclear material removal.5,6,12,21-24 As more vitreoretinal surgeons make the switch to 27-gauge

Figure 5. Twenty-seven-gauge cannulas and a 27-gauge max-grip forceps are used to pass Gore-Tex sutures in a handshake technique for scleral fixation of an intraocular lens.
systems, more techniques to achieve surgical goals efficiently will undoubtedly be developed and refined. Will 27-gauge vitrectomy be the next sweet spot? We will have to stay tuned.

REFERENCES


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