

The Progress of MINIMALLY INVASIVE VITREOUS SURGERY

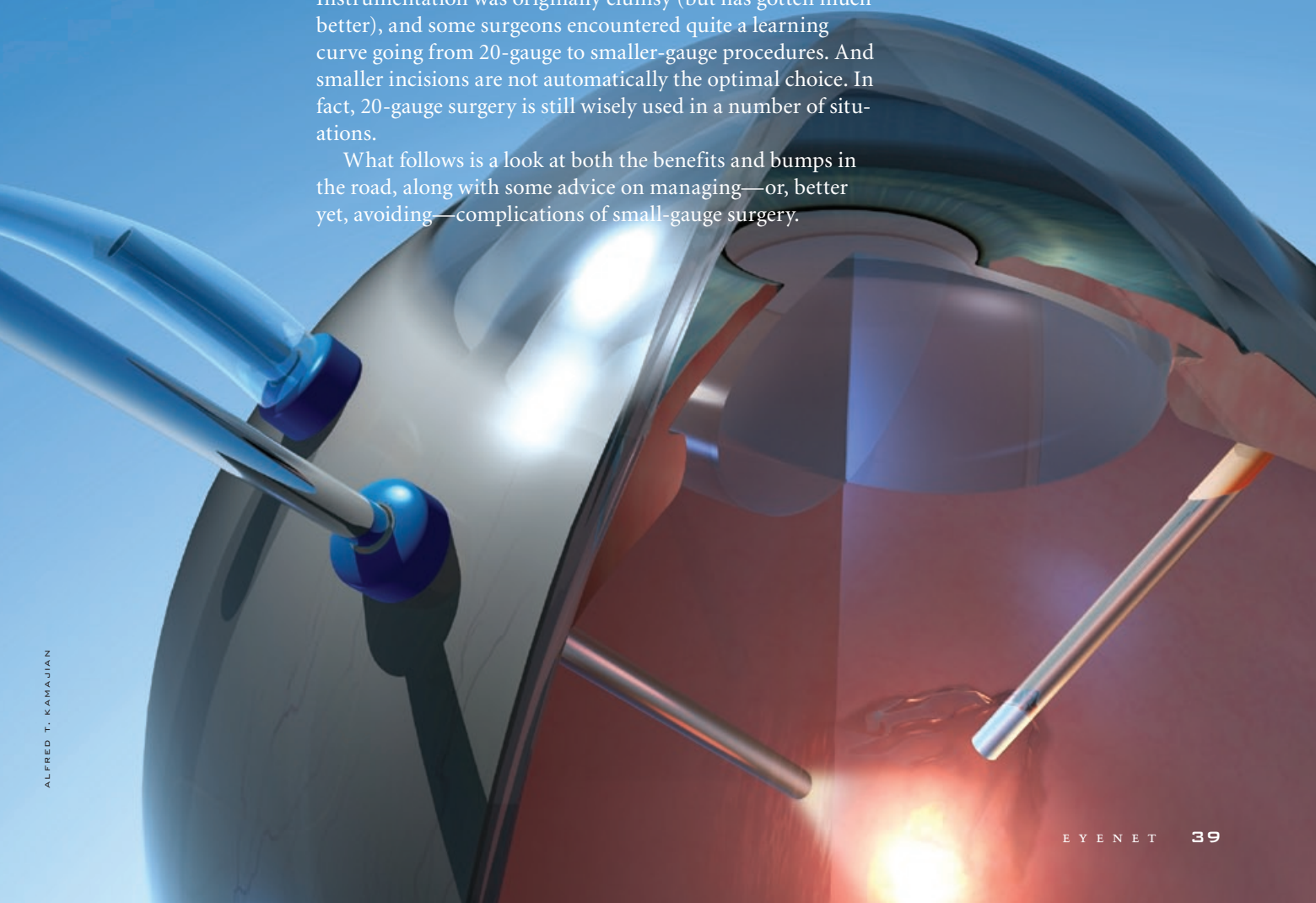
BY ANNIE STUART, CONTRIBUTING WRITER

Thanks to little revolutions in technology and technique, contemporary vitrectomy is achieving better outcomes for patients and surgeons alike.

Many surgeons agree that sutureless, small-incision surgeries make for happier, quieter eyes in the vitreoretinal patient. The advantage over larger-gauge procedures comes primarily from reduced postoperative inflammation at the sclerotomy site, leading to speedier recovery. But that's not all—the operating time is reduced, which, of course, cuts costs, and the small incisions are especially appropriate for working on the eyes of children. Although originally used for macular diseases, 23- and 25-gauge surgeries have progressed so much in recent years that they are the approach-of-choice for most vitreoretinal procedures.

The smaller gauges have not been without frustrations: Instrumentation was originally clumsy (but has gotten much better), and some surgeons encountered quite a learning curve going from 20-gauge to smaller-gauge procedures. And smaller incisions are not automatically the optimal choice. In fact, 20-gauge surgery is still wisely used in a number of situations.

What follows is a look at both the benefits and bumps in the road, along with some advice on managing—or, better yet, avoiding—complications of small-gauge surgery.



A Bounty of Benefits The advantages of small-gauge, sutureless incisions are varied and range from the comfort of the patient to the cost and satisfaction for the surgeon. Here are three prominent attractions of going smaller.

1. Skipping the sutures. What's the big draw for avoiding sutures? "Patients do better and have less irritation without sutures, which can leave inflammatory nodules on the surface of the eye and can take weeks, sometimes longer, to reabsorb," said Manfred A. von Fricken, MD, a vitreoretinal surgeon in private practice in Fairfax, Va.

In addition, without large incisions and sutures and the telltale red eyes that often follow in their wake, patients sometimes feel as though they haven't even had surgery, said Marc J. Spirn, MD, a surgeon at Wills Eye Institute and instructor in ophthalmology at Thomas Jefferson University in Philadelphia. There is a visual benefit, as well: Without the warping of the eye's surface from sutures, patients experience less corneal astigmatism after the surgery.

2. Better for kids. Smaller incisions and instruments can be particularly compatible for the small eyes of pediatric patients, said J. Fernando Arevalo, MD, professor of ophthalmology at the Universidad de los Andes in Mérida, Venezuela, and director of the Clínica Oftalmológica Centro in Caracas. He suggests their use for select cases of persistent fetal vasculature, retinopathy of prematurity, uveitis and some instances of uncomplicated tractional or rhegmatogenous retinal detachments. "Sometimes it's necessary to go back

to 20-gauge, such as for stage 5 ROP, but for most cases, it makes sense to use the smaller gauge in children," said Dr. Arevalo, who estimates that recovery time has been cut in half for his pediatric patients.

In really small eyes, however, the trocar can be problematic with these small-gauge procedures, said Dr. Spirn. "What I've done in a few cases is make a 23-gauge incision and use a 23-gauge or 25-gauge instrument without the trocar," he said. And, because he tends to suture those eyes, he usually takes down a small section of the conjunctiva to better visualize the wound and minimize the risk of hypotony.

3. Reducing operative time (and expense). Aside from improved outcomes for patients, the potential for reducing operative time is also an advantage, said Steve Charles, MD, clinical professor of ophthalmology at the University of Tennessee in Memphis. "Suturing on the cannula at the beginning and suturing on the wound at the end takes time," he said, "so you can save time and, therefore, money, since 70 percent of the cost of surgery is labor."

Dr. von Fricken, who referred to Dr. Charles as one of the pioneers of vitreous surgery, added that a bit of the time-savings in closing and suturing is sometimes eaten up by the use of smaller instruments, which can prolong tasks conducted inside the eye. But newer instruments and more rigid probes are speeding up the process of the vitrectomy. Furthermore, new platforms have been developed to control duty cycles and cutting rates and to improve fluidics.

A Quick History and Future of Small-Gauge Vitrectomy

Introduced by Robert Machemer nearly 40 years ago, the predecessor to sutureless vitreous surgery was 17-gauge pars plana vitrectomy using a multifunctional vitrector through a single port.¹ During the 1980s and '90s, the standard of care became a three-port pars plana sclerotomy system using 20-gauge instrumentation.² Described by J. C. Chen, sutureless PPV for 20-gauge instruments first came on the scene in 1996.³ At that time, introducing instruments through a self-sealing, scleral-tunnel sclerotomy was a novel approach, if not without challenges. Complications such as wound leakage, vitreous incarceration and retinal tears ensued. And conjunctival dissection and suturing were still often required.⁴

Then the introduction of small-trocar cannulas paved the way for greater advances in vitreoretinal surgery. In 1990, Eugene de Juan developed 25-gauge instruments, but the 25-gauge transconjunctival sutureless vitrectomy wasn't introduced

until 2002 by G. Y. Fuji.² Sharing characteristics of both its forerunners, 23-gauge vitrectomy soon followed, developed by Claus Eckardt, in 2005.⁴ It was smaller than 20-gauge but more rigid than 25-gauge, making procedures such as endolaser and shaving of the vitreous gel easier for some surgeons.²

Going Even Smaller? The 27-gauge vitrectomy, not yet available in the United States, got its start in Japan, where it's being used on a limited basis for procedures such as macular surgery or floaters, said Dr. Charles.

There are some questions among U.S. ophthalmologists on how small is too small. "If there is a way to make 27-gauge comparable in terms of stiffness to 23-gauge or 25-gauge, then I think people will move toward smaller instrumentation," said Dr. Spirn. Dr. von Fricken, however, said there comes a point of diminishing returns. "As you make smaller openings, you're violating the eye less, but it's also more dif-

Problems Addressed Progress never arrives without problems, and in the early days of sutureless, small-incision vitreous surgery, surgeons were hampered by limited options for illumination and other instrumentation and a steep learning curve.

Choices in instruments expanding. Illuminated instruments were especially unhelpful for 25-gauge procedures, which could accommodate fewer light fibers. But today this is much less of an issue, especially with the introduction of the illuminator in Alcon's Constellation Vision System, which boasts a bright light, said Dr. Arevalo.

Surgeons were once also limited to forceps for the smaller vitrectomies. "But several different companies started to develop instruments to work with the smaller systems," said Dr. von Fricken. These now include Bausch & Lomb's 23- or 25-gauge Millennium system; Alcon's 23- or 25-gauge Accurus and Constellation Vision systems; and Dutch Ophthalmic Research Centre's 23- and 25-gauge systems.

Today, it is easy to find a wide range of vitreous cutters, chandeliers, curved scissors, microvitreoretinal blades, aspirating picks and endoscopic laser probes for both 23- and 25-gauge. This, in turn, has made it possible to expand the indications for these procedures, said Dr. von Fricken. "Now we can do most cases with either 23-gauge or 25-gauge."

Vitreous cutters have made an especially notable difference in the small-incision experience: The opening of the vitreous cutter is closer to its tip, said Dr. Arevalo, which has allowed for a closer vit-

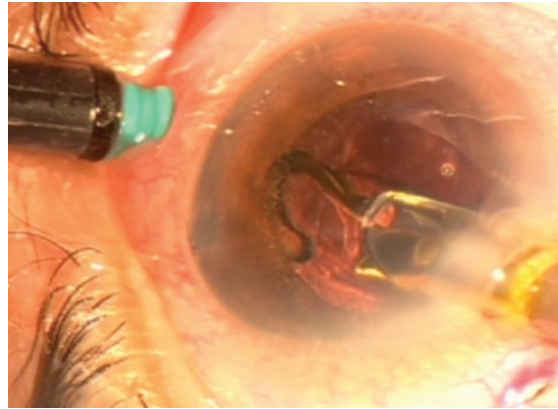
reous shave and less risk to the retina. Sometimes the surgeon can dispense with the vitreous cutter altogether, he added, which makes for a simpler, quicker procedure.

One notable absence in the 23- or 25-gauge armamentarium is an ultrasound fragmentome for handling the crystalline lens, said Dr. Arevalo. "Now when we need to phacoemulsify the lens, we have to open a 20-gauge sclerotomy to insert the fragmentome," he said, adding that this requires opening the conjunctiva, which can lead to suturing to avoid complications.

Learning curves—25G vs. 23G. "What I liked initially about 25-gauge vitrectomy was the cutter and the fluidics," said Dr. von Fricken. "But it took some time to get used to the instruments being more flexible and the trocars pulling out on occasion." He gradually expanded to doing almost all retinal detachment surgeries with 25-gauge instrumentation and found no significant differences in outcomes when comparing small-gauge retinal re-

attachment surgeries with surgery using 20-gauge instruments. Dr. von Fricken said that 25-gauge vitrectomy is ideally suited for macular surgeries, most diabetic vitrectomies and retinal detachment procedures. He suggests that surgeons approach the 25-gauge surgery much like learning to play a musical instrument: "One has to practice."

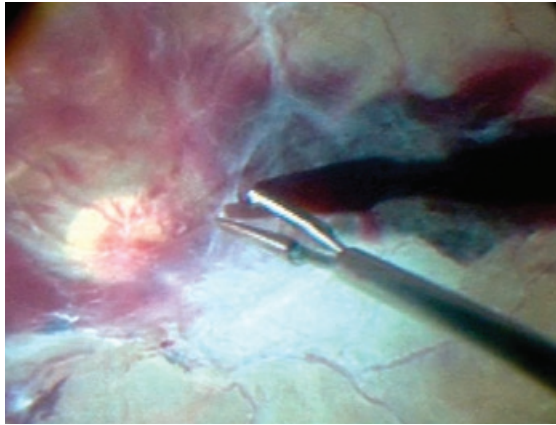
Because of its similarity to 20-gauge in terms of rigidity, lighting, flow and aspiration of the vitreous cutter, 23-gauge might be an easier switch and have a smaller learning curve for some, said Dr. Arevalo, who uses it for about 80 percent of his cases. Although flexibility of the 25-gauge can be a problem, he said this should become less of an issue now with the introduction of the Alcon 25+ line of instruments.



Combined procedure: 25-gauge vitrectomy and IOL implantation.

Picking up the pieces. Aside from instrument stiffness, which is particularly helpful when doing

1 Machermer, R. et al. *Trans Am Acad Ophthalmol Otolaryngol* 1971;75:813–820.
2 Warrier, S. K. et al. *Indian J Ophthalmol* 2008;56(6):453–458.
3 Chen, J. C. *Arch Ophthalmol* 1996;114:1273–1275.
4 Oshima, Y. et al. *Ann Acad Med* 2006;35(3):175–180.



Diabetic tractional retinal detachment managed with 23-gauge surgery.

peripheral endolaser, said Dr. Spirn, the 23-gauge system offers another advantage. “I think 23-gauge is also helpful when doing fragmentation because it’s easier to remove the fragments, which you can sometimes do without a fragmatome.”

Some surgeons think of the 23-gauge as the best of both worlds: stiffness combined with the sutureless approach. But others disagree. “I tried some 23-gauge but didn’t see any real advantage,” said Dr. von Fricken. “I was already used to the 25-gauge instruments and felt that the smaller holes in the sclera led to a lowered risk of wound leaks and postoperative hypotony.”

Dr. Charles said the rigidity problem was overstated from the beginning. “Now, improvements in the Alcon 25+ system put it in the range of 23-gauge in terms of illumination, fluidics and rigidity,” he said. “It’s worth a second try for those who used early 25-gauge technology and have never gone back to reevaluate it.”

Complications, and Tips for Reducing Them An ongoing controversy regarding the correlation between hypotony and endophthalmitis surrounds small-gauge vitrectomy. But, “Hypotony never caused endophthalmitis,” asserted Dr. Charles. “What causes endophthalmitis are vitreous wicks. It’s true that there is some correlation with softer eyes, but it isn’t that there’s a wound leak. If you have a wound leak, the aqueous runs out the hole. But if you leave the sclerotomy filled with vitreous, thinking that somehow plugs it, then vitreous hangs out the conjunctival space. That’s what causes endophthalmitis.”

Dr. Spirn wants the complication rate quantified. “I think the biggest remaining hurdle is clarifying the rate of endophthalmitis and trying to reduce the rates with small-incision surgery,”

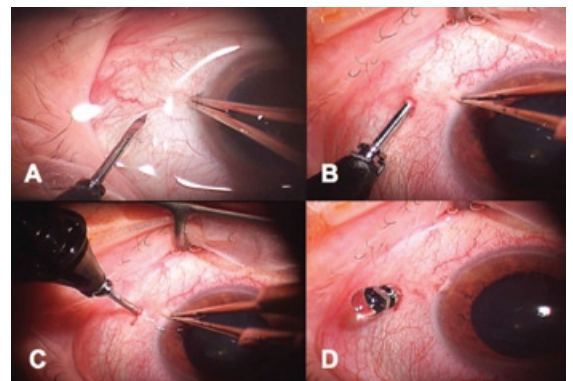
he said, adding that studies have shown anywhere from an equal risk to a 28-fold greater risk of endophthalmitis with 25-gauge vitrectomy compared with 20-gauge.¹ This has prompted some to stay put with 20-gauge procedures, he said.

Fortunately, several techniques have emerged to address concerns about complications:

- **Wound architecture.** Conjunctival displacement—misaligning the conjunctival and scleral entry sites—allows the conjunctiva to cover the wound and has been one important aspect of wound construction, said Dr. Charles. And, constructing scleral tunnels by an oblique wound—incorrectly referred to as a beveled or biplanar wound, he noted—is a second critical step. Dr. von Fricken added that angling the trocar creates a flap that pressure-closes when the instruments and trocar are pulled out. In rabbits, angled incisions like these cut leakage in half.² New 25-gauge trocars, said Dr. von Fricken, allow for construction of a wound more likely to be self-sealing.

- **Fluid-air exchange.** As popularized by Dr. Charles, another approach to minimizing postoperative wound leakage and subsequent complications is the use of fluid-air exchange at the end of a vitrectomy. This allows for more complete filling of the sclerotomies. If leakage does occur, however, a solution is to close the sclerotomy site with a 7-0 or 8-0 Vicryl suture, Dr. Arevalo said.

- **Antibiotics.** Injection of postoperative antibiotics is needed to reduce the risk of endophthalmitis, even with “a beautiful 25-gauge sutureless vitrectomy,” said Dr. Charles. Drops don’t make the grade, he said, given the 100:1 antibiotic concentration gradient between the front and back of



In a 23-gauge vitrectomy, microcannulas are inserted through the conjunctiva by way of a trocar (A). Conjunctiva is displaced laterally approximately 2 mm (B). An oblique, then perpendicular, tunnel traverses parallel to the limbus through the conjunctiva and sclera (C), making a self-sealing wound (D). After the cannula is withdrawn, a cotton tip is used to misalign the two orifices.

the eye. “Inject subconjunctival antibiotics under the lower lid in the inferior cul-de-sac,” he said, “so if there is a subconjunctival hemorrhage, the patient won’t see it and the antibiotics can’t reflux into the wounds.”

- **High-speed cutting.** This technique is important, not because it cuts better or is more efficient, said Dr. Charles, but because it minimizes pulsatile vitreoretinal traction. “High-speed cutting should be used for all cases and all tasks within those cases,” he said, debunking the view that it should be reserved for peripheral vitreous shaving and that high flow rates and slow cutting rates are needed for core vitrectomy. Dr. Arevalo added, “The cutting rates have come up to 5,000 cuts per minute, which allows you to shave the vitreous very close to the retina, even if the retina is detached, without having the retina moving toward the cutter.”

Is 20-Gauge a Dying Breed? Given the benefits of smaller-incision procedures, why do surgeons continue to perform 20-gauge vitrectomy?

Dr. Arevalo said that although it commands a very small percentage of his cases now, 20-gauge still has a role for complicated cases and for those situations when opening the conjunctiva and sclera is necessary, such as for scleral buckling and phaco fragmentation.

Right after the advent of the 25-gauge, Dr. Charles introduced the idea of the 20-25 hybrid vitrectomy for that very purpose: fragmenters were only available for 20-gauge. “So I enlarged one wound, introduced the fragmenter and took out the lens material,” he said. “Then I invented an adapter—basically a sleeve with a flange on it—which you can put in the now-enlarged wound and make it small again to finish the vitrectomy.”

Other than this, Dr. Charles prefers 25-gauge over 20-gauge in all cases. “This isn’t some kind of specialized technique only for certain cases,” he said. “A major misconception in the vitreoretinal community, one which I’d like to dispel, is the notion that it’s all about cherry-picking easy cases to do this way and that if it’s a retinal detachment or a diabetic traction retinal detachment, you should do it the conventional 20-gauge way. That’s simply incorrect.”

Drs. Arevalo and Spirn do, however, also prefer the hybrid for removal of silicone oil. “I find that doing oil removal through 23- or 25-gauge is tedious, that it’s not always easy to remove it all,” said Dr. Spirn. “I use an 18-gauge angiocatheter to remove the oil. Even with 1,000-centistoke oil, I think it’s advantageous to do a hybrid.”

Dr. Charles, on the other hand, no longer uses a hybrid with silicone oil. He favors 1,000-cen-

tistoke oil, given that it’s less viscous and there’s no evidence, he said, that it’s inferior to 5,000. Dr. Charles said he finds it possible now to do all silicone oil cases by 25-gauge, with the help of the MedOne Viscous Fluid Injection system.

With many technological advances and with varied instruments and enhancements in technique, small-incision vitrectomy has clearly made its mark on vitreoretinal surgery.

1 Scott, I. U. et al. *Retina* 2008;28:138–142.

2 Spirn, M. J. *Curr Opin Ophthalmol* 2009;20:195–199.

Vitrectomy in Chicago

On Tuesday, Oct. 19, the Joint Meeting will offer a number of presentations on vitrectomy, including:



Diabetic Vitrectomy (event code IC 541) from 9 to 10 a.m.

Comprehensive Strategy for Unplanned Vitrectomy—Technique for the Anterior Segment Surgeon (event code IC 543) from 9 to 11:15 a.m.

23-Gauge Vitrectomy Surgery: Principles and Technique (event code LEC 549) from 9 to 11:15 a.m., and a Skills Lab of the same name (event code LAB 549A) from 3:30 to 5 p.m.

Meet the Experts



J. FERNANDO AREVALO, MD Professor of ophthalmology at the Universidad de los Andes in Mérida, Venezuela, and director of the Clínica Oftalmológica Centro in Caracas. *Financial disclosure: None.*

STEVE CHARLES, MD Engineer of ophthalmic devices and in private practice in Memphis; clinical professor of ophthalmology at Hamilton Eye Institute at the University of Tennessee in Memphis. *Financial disclosure: Is a consultant for Alcon.*

MARC J. SPIRN, MD On staff at Wills Eye Institute and instructor in ophthalmology at Thomas Jefferson University in Philadelphia. *Financial disclosure: None.*

MANFRED A. VON FRICKEN, MD Vitreoretinal surgeon in private practice in Fairfax, Va. *Financial disclosure: None.*