Current Status of Small-gauge Vitreoretinal Surgery

Recent advances have helped to overcome the disadvantages initially encountered with this technique.

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Pars plana vitrectomy (PPV) was introduced almost 40 years ago. In the decades of the 1980s and 1990s, three-port PPV with 20-gauge instrumentation was the norm. In 2002, 25-gauge vitrectomy was introduced. These systems permit three-port PPV using microcannulas, trocars, and 25-gauge instrumentation without requiring sutures to close the sclerotomies. Subsequently, a similar technique but with 23-gauge instrumentation was developed. Currently, the most popular two small-gauge vitrectomy techniques are performed utilizing 25-gauge and 23-gauge instrumentation.

The objective of this article is to review the current status of small-gauge vitreous surgery.

INSTRUMENTATION FOR SMALL-GAUGE VITRECTOMY

Small-gauge vitrectomy is performed with a 23-gauge or 25-gauge microcannular system and a wide array of vitreoretinal instruments specifically designed for this operating system. The microcannula is a thin-walled tube 4 mm in length. A collaron the extracocular portion, and can be grasped with a forceps to manipulate the microcannula. The insertion trocar has a sharp tip that forms a continuous bevel with the microcannula, allowing ease of entry through the conjunctiva into the eye (Figure 1). The 25-gauge infusion cannula consists of a small tube that fits neatly and can be directly inserted into the cannula in the inferotemporal quadrant. A wide array of vitreoretinal microsurgical instruments complying with the 25-gauge standards has been designed. These include vitreous cutters, illumination probes, intraocular...
forceps, microvitreoretinal (MVR) blades, tissue manipulator, aspirating picks, aspirators, soft-tip cannulas, curved scissors, extendable curved picks, intraocular laser probes, and diathermy probes.

**SURGICAL TECHNIQUE**

Small-gauge vitrectomy is usually performed with the patient under local anesthesia. General anesthesia is only performed in selected cases. After appropriate anesthesia, the operative field is prepared using antiseptic solutions. Preoperatively, the eyelash margins are scrubbed with povidine-iodine solution. The microcannulas are inserted through the conjunctiva into the eye by means of a trocar. Insertion is accomplished by first displacing the conjunctiva laterally by approximately 2 mm. An initial oblique, then perpendicular tunnel is made parallel to the limbus through the conjunctiva and sclera, thus, creating a self-sealing wound. After insertion of the first microcannula, the intraocular portion of the infusion cannula is directly inserted into the external opening of the microcannula.5,6 The other two microcannulas are inserted in the superotemporal and superonasal quadrants for a three-port vitrectomy. At the completion of surgery, the microcannulas are simply removed by grasping the collar and withdrawing, with assessment of intraocular pressure (IOP) and wound sites for any possible leak.

The 23-gauge system is a variation of the 25-gauge small-gauge vitrectomy system. The 23-gauge vitreous cutters have been improved by placement of the cutter opening nearer to the end of the probe, which allows a closer vitreous shave, thus increasing the safety near the retina. At the end of the vitrectomy, an adequate gas or air tamponade must be performed; this prevents significant postoperative leakage in most cases. In some cases, however, leakage can occur; if so the sclerotomy site can be closed with a single 7-0 or 8-0 vicryl suture. The microcannulas can be simply removed by grabbing the external collar with forceps at the end of the procedure (Figure 2). The last microcannula to be removed should be the one with the infusion line. Postoperative subconjunctival injection of antibiotic and steroid solutions can and should be administered similarly to standard vitrectomy. Endophthalmitis is extremely uncommon following vitreous surgery, but there is a theoretical concern that 25-gauge sutureless surgery may be associated with an increased risk of endophthalmitis.7,8

**ADVANTAGES OF SMALL-GAUGE VITRECTOMY**

In general, small-gauge vitrectomy seems to be particularly advantageous for procedures that do not require extensive intraocular tissue dissection or manipulation. Experience has shown that 25-gauge surgery is ideal for vitreous hemorrhage, rhegmatogenous retinal detachment, proliferative vitreoretinopathy (PVR), giant retinal breaks, and cases in which we combined vitrectomy and phacoemulsification with intraocular lens (IOL) implantation (Figure 3). Small-gauge vitrectomy is also applicable for diabetic traction retinal detachment with moderate amounts of epiretinal membranes. However, if use of scleral buckling or silicone oil tamponade is anticipated, the standard 20-gauge vitrectomy system is preferred, as its full capability may be required in those cases. Even in complex cases where we need a variety of scissors and forceps and/or injection of silicone oil, 25-gauge or 23-gauge sclerotomies can be used for the infusion and illumination probe, and a 20-gauge sclerotomy can be made for instruments and the injection or removal of silicone oil at the end of surgery. This enables the surgeon to use 20-gauge instruments and reduce the costs of replacing...
Small-gauge vitrectomy can also be advantageous for pediatric cases. Typically, newborn and premature eyes are significantly smaller than adult eyes, and the use of standard vitrectomy instruments may introduce technical difficulties related to the ocular size. Using small-gauge vitrectomy, the intraocular instruments are more compatible with smaller pediatric eyes and are effective in selected cases of persistent fetal vasculature, retinopathy of prematurity, uveitis, and some uncomplicated tracional or rhegmatogenous retinal detachments. In addition, transconjunctival, small-gauge vitrectomy-based surgery has the potential to reduce operative duration for a variety of procedures. It also reduces postoperative inflammation at sclerotomy sites, thus reducing patient discomfort after surgery and hastening postoperative recovery. It also helps to reduce the risk of induced astigmatic changes, with more rapid visual recovery.

**DISADVANTAGES OF SMALL-GAUGE VITRECTOMY**

The disadvantages of transitioning to small-gauge vitrectomy include a learning curve to achieve maximum efficiency. However, the curve is short enough for the adaptable surgeon. Due to the smaller fiberoptic size, illumination is also reduced in 25-gauge surgery. The illumination provided by current systems, however, is adequate in most cases. The most noticeable difference in the 25-gauge instruments is their increased flexibility.

There are some potential complications specifically related to the 25-gauge system, the most obvious being hypotony and the potential for increased incidence of endophthalmitis with 25-gauge. The incidence of these complications can be reduced by building a tunnel or angular incision, in a different plane from the conjunctiva, and performing an fluid-air exchange at the end of the surgery. It is important to note that the incidence of hypotony is higher in eyes previously vitrectomized.

In term of prophylaxis, all patients undergoing 25-gauge vitrectomy should have the standard meticulous preparation with povidone-iodine as well as postoperative injection of subconjunctival antibiotics. In addition, patients are instructed to remove the eye patch on returning home from surgery and to start topical antibiotics every hour while awake postoperatively.

For the surgeon accustomed to performing 20-gauge vitrectomy, the transition is easier to 23-gauge than to 25-gauge surgery. Rigidity, flow, and aspiration of the vitreous cutter in 23 gauge are similar to 20 gauge, and the lighting is comparable. The instruments have stiffness similar to 20-gauge. The construction of the incisions must be meticulous using tunnel or angled incisions to reduce complications.

**RECENT ADVANCES OVERCOME DISADVANTAGES**

**Instrument Rigidity**

The 25-gauge instruments are more pliable and can bend and break, and moving the globe around can be cumbersome. This is not a problem with 23 gauge; rigidity is similar to 20 gauge (Figure 4). In addition, several companies are making new 25-gauge instruments that are more rigid in construction and/or shorter in length to achieve the same purpose.

**Instrumentation Availability**

Although initially instrumentation was limited to forceps in small gauge, at present a full armamentarium of instruments is available in small-gauge. Included in the
line of instruments for small-gauge vitrectomy are extrusion cannulas for silicone oil injection and removal; scissors; dual-bore cannulas for perfluorocarbon injection; diathermy and multidirectional laser probes; chandeliers; and 40-gauge cannulas for subretinal injections. In essence, at present the same range of instruments that are used in 20 gauge are available in 23 and 25 gauge, with the exception of the fragmentome. Currently, several companies are working to develop a 23-gauge fragmentome to address dislocated nuclei.

Illumination
Because the size of light fibers is reduced in small-gauge vitrectomy, particularly with 25 gauge, brighter light sources are required. Two examples of brighter lighting are the Photon (Synergetics, Inc., O’Fallon, MO) and the Xenon (Alcon Laboratories, Inc., Fort Worth, TX).

Cutting Efficiency
Slow vitreous removal is a problem with 25-gauge technology at present but is addressed in the new Constellation Vision System (Alcon Laboratories, Inc.). The new 25-gauge probe has a bigger opening and a longer duty cycle (amount of time port is open), which allow increased aspiration rate while maintaining high-speed cutting rates. The 23-gauge system will benefit from the same duty cycle improvement. The probe is different, and does not have a spring mechanism so it can stay open longer during each cut, allowing greater aspiration. Thus, the rapidity of vitreous removal with 23 and 25 gauge will be markedly improved. Cutting rates of up to 5,000 cpm are available, allowing shaving of the vitreous base and safer vitrectomy, even in detached retinas.

Wound Architecture
Wound architecture is the most important aspect of this surgery, as complications such as endophthalmitis and retinal breaks are associated with the incisions made in small-gauge vitrectomy. Initially, wounds were made in 25-gauge by direct entry, possibly one of the causes of hypotony and potentially increased endophthalmitis rates. Displacement of the conjunctiva and two-plane wounds with fluid-air exchange at the end of the procedure have reduced wound leaks, resulting in less risk of endophthalmitis and hypotony. The new DORC (Zuidland, The Netherlands) and Alcon 23-gauge small-gauge vitrectomy systems will have a flat blade trocar system that will produce a slit wound, which closes better than the chevron wound made by the round trocar blade system. In our opinion, wound construction is the most important aspect of surgery and the hardest thing for the surgeon to learn. An important tip: When in doubt, suture. Further, our threshold to suture a sclerotomy tends to be lower in complicated cases where silicone oil must be used.

Surgical Outcomes
Benefits of small-gauge vitrectomy include astigmatically neutral surgery (which is important in this age of refractive surgery), shortened surgery time, less inflammation, and a higher level of patient discomfort compared with 20-gauge surgery. We truly believe that the increased incidence of endophthalmitis is technique dependent. With adequate preoperative povidone-iodine preparation, good wound construction in two steps, partial or total fluid air exchange at the end of the procedure, and subconjunctival antibiotics, the complications of hypotony and endophthalmitis can be reduced.

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