

27-gauge Vitrectomy

The use of these smaller instruments in vitrectomy surgery is both possible and optimal for completely self-sealing wounds.

BY YUSUKE OSHIMA, MD, PhD

Current microincision vitrectomy surgery (MIVS) with 25- or 23-gauge instrumentation has simplified the vitrectomy procedure and offers numerous potential advantages over 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.¹⁻⁶ Are current procedures, however, really the simplest and most minimally invasive? Currently, complex techniques are required for self-sealing 23- and 25-gauge wounds.^{2,7,8} Additionally, reports of wound-sealing-related complications, such as hypotony and endophthalmitis, have surfaced as a result of increasing use of MIVS with 23- and 25-gauge instrumentation.⁹⁻¹¹

Prior to the introduction of MIVS, smaller-gauge instruments have been used for postoperative management of vitrectomized eyes. For example, we have performed transconjunctival fluid-fluid exchange and fluid-air exchange through a 27-gauge needle for many years, and there are no reports of serious complications related to wound integrity with a 27-gauge needle. Therefore, I propose that 27-gauge (0.40 mm) may be the best-suited technology for sutureless MIVS.

DEVELOPMENT OF 27-GAUGE VITRECTOMY SYSTEM

A crucial concern in developing small-gauge systems is reduced endoillumination. Fortunately, the recent introduction of more powerful light sources using xenon light (Accurus High Brightness Illuminator, Alcon Laboratories, Inc., Fort Worth, TX; Photon, Synergetics, Inc., St. Charles, MO; BrightStar, DORC, Zuidland, Netherlands) and mercury vapor light (Photon II, Synergetics, Inc.) has enabled us to develop smaller-gauge illumination tools.¹² We have developed a one-step chandelier probe (Synergetics, Inc.) consisting of a 27-gauge needle socket and a 29-gauge inner light fiber (Figure 1A).¹³ Another type of 27-gauge chandelier system using twin optical fibers (Twinlight chandelier illumination system, DORC) has recently become commercially available (Figure 1B).¹⁴ Both types of 27-gauge chandelier illumination are sufficient to illuminate the fundus (Figures 1C and

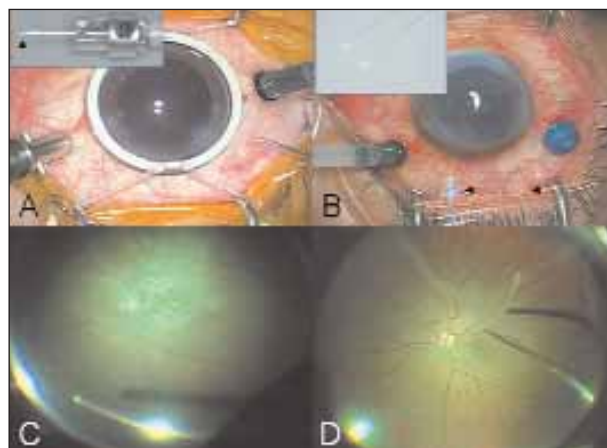


Figure 1. Intraoperative view of 27-gauge three-port vitrectomy system. Transconjunctival placement of a one-step 27/29-gauge chandelier probe through the pars plana in the superonasal quadrant. The image of the one-step chandelier probe is shown in the upper left corner (inset). The tip of the 29-gauge light fiber (arrowhead) can be easily exposed by retracting the outer needle socket (A). Intraoperative view of 27-gauge vitrectomy system with a 27-gauge twin-light chandelier illumination system (arrowheads). The image of the 27-gauge twin-chandelier fibers is shown in the upper left corner (inset, B). Panoramic fundus view under the 29-gauge chandelier endoillumination with mercury vapor light source. Sufficient illumination and wide-angle view of the fundus are obtained (C). Panoramic fundus view under the 27-gauge twin-light chandelier endoillumination with xenon light source (D).

D). At the end of surgery, the scleral wound perfectly self-seals after simple removal of the 27-gauge fibers.

Also available are 27-gauge asymmetrical microforceps (Synergetics, Inc.) for 27-gauge non-vitrectomizing vitreous surgery (Figure 2).¹⁵ At present, several types of 27-gauge fine-tip microforceps such as end-gripping forceps (DORC) and pick forceps (ASICO, Westmont, IL) are commercially available for 27-gauge macular surgery. The stiff shaft and fine tip on the forceps enable grasping of thick or thin internal limiting membranes.

Development of a practical 27-gauge vitreous cutter was

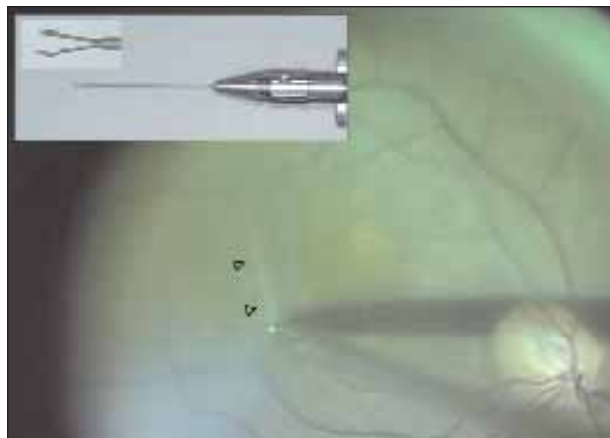


Figure 2. Intraoperative view of epiretinal membrane peeling with a 27-gauge asymmetric microforceps. The tip of the grasping end is fine and rigid enough to catch the edge (arrowheads) of an epiretinal membrane, thus easily peeling the tough membrane from the retina. High magnification of the tip of the microforceps is shown in the upper left corner.

the most crucial step for establishing a 27-gauge vitrectomy system. We developed a prototype pneumatic 27-gauge cutter in collaboration with DORC (Figure 3). The port area of the cutter is wider than that of commercially available 25-gauge cutters (Y. Oshima, unpublished data, 2008). A shorter shaft provides rigidity similar to a conventional 25-gauge cutter. Using a high-speed camera, we evaluated the 27-gauge cutter's duty cycle. Surprisingly, the duty cycle of the 27-gauge cutter was equal to or slightly better than that of a 25-gauge cutter at 1,000 or 1,500 cpm (Y. Oshima, unpublished data, 2008). Based on the duty cycle evaluation and infusion flow rate measurements, we found that the pressure of the vented gas forced infusion system (Accurus High Brightness Illuminator, Alcon Laboratories, Inc.) can be set within a normal range of 20 to 30 mm Hg, providing safe control of intraocular pressure (IOP) during vitrectomy.

In addition to these basic instruments for 27-gauge vitrectomy, several 27-gauge accessories, such as membrane spatula, diamond-dusted membrane scraper, and endolaser probe, have been developed for expanding the surgical indications of 27-gauge vitrectomy.

SURGICAL INDICATIONS, PROCEDURES, AND PRELIMINARY RESULTS

Current indications for transconjunctival 27-gauge vitrectomy are listed in Table 1. Although the performance of the current prototype 27-gauge vitreous cutter has not yet reached the level for treating complex proliferative vitreoretinal pathologies, which often require extensive peripheral vitreous shaving and manipulation, this system is now feasible to supersede a 25-gauge system to

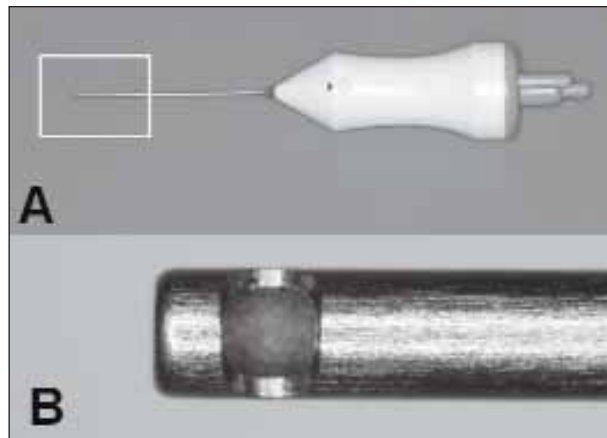


Figure 3. Whole image of a 27-gauge pneumatic vitreous cutter (A). High magnification of the port of the vitreous cutter (B). The port on the 27-gauge cutter is wide enough and close enough to the tip to allow excision of fibrovascular membranes on the retinal surface more easily and safely than 23- and 25-gauge cutters.

treat macular diseases, simple vitreous hemorrhage, and moderately severe proliferative diabetic retinopathy.

The 27-gauge system offers several advantages over the currently widely used 23- and 25-gauge systems. Using the 27-gauge system removes concerns about complications related to wound-sealing. In a pilot study approved by the institutional review board, we have performed 27-gauge vitrectomy in 28 eyes of 28 patients for a variety of vitreoretinal diseases, including epiretinal membrane proliferation, idiopathic macular hole, diabetic vitreous hemorrhage with fibrovascular membrane proliferation, and nonclearing vitreous opacity. The settings for 27-gauge vitrectomy are similar to that for 23- and 25-gauge instrumentations;

TABLE 1. CURRENT INDICATIONS FOR 27-GAUGE VITRECTOMY

Macular diseases

- Epiretinal membrane proliferation
- Idiopathic or secondary macular hole
- Macular traction syndrome
- Macular edema associated with diabetic retinopathy, retinal vein occlusion, or uveitis
- Persistent pseudophakic cystoid macular edema
- Subinternal limiting membrane hemorrhage

Simple vitreous hemorrhage

Vitreous biopsy

Moderate proliferative diabetic retinopathy with or without focal tractional retinal detachment

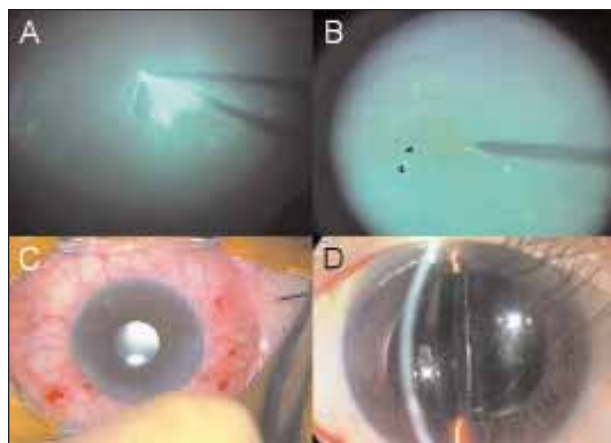


Figure 4. Standard procedures for 27-gauge macular hole surgery. Suction from the 27-gauge vitreous cutter is sufficient to create a posterior vitreous membrane separation from the retina (A). The Weiss ring can be well visualized by intravitreal injection of triamcinolone acetonide. Internal limiting membrane (arrowheads) was carefully peeled by use of end-gripping microforceps (B). At the end of surgery, the sclerotomies can easily and completely self-seal by simple removal of the 27-gauge instruments (C). No remarkable changes on the ocular surface observed even at postoperative day 1 (D).

however, complex techniques for creating a self-sealing wound, such as angled-insertion technique^{7,8} or two-step entry method,² are no longer required. The 27-gauge vitrectomy can begin immediately after sclerotomies at the pars plana by simple vertical insertion using a 27-gauge needle. A 27-gauge trocar-cannula system is available but not necessary for all cases because the small gauge eliminates concerns about extensive vitreous incarceration in the small sclerotomy. After simple removal of all instruments, surgery can be closed at once and all sclerotomies self-sealed completely without the need for suturing. Using the 27-gauge system, opening and closing procedures can be simplified, and this may contribute to saving total operating time with this system. In our series, the IOP of all 28 eyes was stable from postoperative day 1 without any eyes encountering hypotony (≤ 7 mm Hg) throughout the follow-up period (mean, 6.3 months), suggesting perfect self-sealing structures of the 27-gauge wounds. The 27-gauge sclerotomy can no longer be identified even on postoperative day 1, and there are no remarkable changes on the ocular surface in most cases (Figure 4). Because of its small size, the 27-gauge cutter can play several roles concurrently during surgery (ie, as a cutter, aspirator, peeling forceps, and membrane scissors). Reducing the use of various instruments for manipulation may eliminate time wasted in instrument exchanges and also contribute to saving total operating time. The mean operating time in the 28-eye study was

30 minutes. No eyes required conversion to larger-gauge instrumentation during surgery. No serious intra- or post-operative changes were observed during follow-up. Anatomic success was achieved in all study eyes, including visual improvement by three lines or more in 70% at the latest follow-up examination.

FUTURE PERSPECTIVE

Although the development of 27-gauge vitrectomy is an ongoing project and has not yet been established as a widely accepted system, the feasibility and safety of 27-gauge vitrectomy in selected cases have been demonstrated and confirmed.¹⁶ Further development and refinement of the 27-gauge instruments' stiffness and functionality will continue over the coming years and allow us to establish an ultra-minimally invasive surgery system for vitreoretinal diseases in the near future. ■

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