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25-, 23-, or 20-gauge instrumentation for vitreous surgery?

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Abstract

Purpose **To discuss the evolution and current status of 25-, 23-, and 20-gauge vitrectomy instrumentation.**

Methods **Literature review.**

Results **There are multiple small case series describing the surgical techniques, clinical outcomes, and complications associated with 25- and 23-gauge vitrectomy. These studies suggest that small-gauge vitrectomy may shorten operating time, improve patient comfort, and speed visual recovery. However, increased complication rates involving hypotony and endophthalmitis have been reported. There are no level 1 evidence-based studies comparing the efficacy and safety of 25-, 23-, and 20-gauge vitrectomy.**

Conclusion **25- and 23-gauge vitrectomy techniques may shorten operating time, improve patient comfort, and speed visual recovery. However, larger and better designed evidence-based studies are required to better understand relative values of 25-, 23-, and 20-gauge vitrectomy.**

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Introduction

Since the advent of vitrectomy in the early 1970s, there has been a continuing evolution in vitrectomy techniques, indications, and instrumentation. Concomitant with this evolution, surgical and visual outcomes have steadily improved. Today, it is estimated that over 500 000 people worldwide undergo vitrectomy surgery each year. In the United States Medicare program, vitrectomy procedures increased 93% from 58 130 in 1995 to 112 422 in 2005 (www.cms.hhs.gov). Considering the likely development of new indications and the ageing populations in the United States, Europe, and Japan as well as the increased access to vitrectomy in the rest of the world, the growth in vitrectomy procedures will continue.

The first vitrectomy system described by Machemer[1] in 1971 consisted of a multifunction single-port device with cutting, suction, and infusion combined. The device was 1.5 mm in diameter (17 gauge) and used coaxial illumination from the operating microscope. A second generation device employed a light sleeve for intraocular illumination and used a pars plana transscleral cannula requiring a 2.3 mm sclerotomy.[1] In 1974, O'Malley[2] described a three-port system with separate 20-gauge (0.89 mm) instruments for the vitreous cutter, infusion, and endoillumination, respectively. A scleral incision of approximately 1.1 mm was required for instrument entry. This approach also required conjunctival dissection and sutured closure of the sclerotomy sites. Although numerous modifications and improvements were introduced on an almost yearly basis, the 20-gauge, three-port system remained the standard for pars plana vitrectomy for the next 30 years.

In 2002, Fujii *et al*[3,4] introduced the first commercially available, sutureless, transconjunctival 25 (0.50 mm)-gauge vitrectomy system. In 2005, Eckardt[5] described a 23-gauge transconjunctival sutureless system. Subsequently, other manufacturers have released competing 23- and 25-gauge systems. The Practice and Trends (PAT) survey of the American Society of Retina Specialists indicates growing use of both 23- and 25-gauge systems throughout the world. In the 2006 PAT survey, 88% of respondents used 23- or 25-gauge systems and 46% did so frequently (www.asrs.org). A PubMed search for 23-gauge vitrectomy and 25-gauge vitrectomy on 31 August 2007 found 114 publications describing indications, techniques, instrumentation, results, and complications. The current availability of 20-, 23-, and 25-gauge vitrectomy systems provides surgeons with enhanced flexibility but creates a variety of questions concerning the respective advantages,

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disadvantages, and indications for each system. This paper will review the current status of 25- and 23-gauge vitrectomy surgery.

25-gauge vitrectomy

In 1990, de Juan and Hickingbotham[6] described a series of 25-gauge vitrectomy instruments including a vitreous cutter, a forceps, and a membrane dissector. However, these instruments were never commercialized. In 2002, Fujii *et al*[3] introduced the first commercially available transconjunctival, sutureless 25-gauge vitrectomy system (Bausch and Lomb, Rochester, NY, USA). This system is based upon microcannulae for three-port pars plana vitrectomy and includes a variety of instruments for illumination and retinal dissection. The microcannula consists of a polyamide tube 3.6 mm in length with an inner and outer diameter of 0.57 and 0.62 mm respectively. The cannula has a funnel-shaped collar for manipulation of the cannula and improved instrument entry. The cannula is inserted through the conjunctiva and sclera with a sharp trocar. During insertion of the cannula, the conjunctiva is displaced to misalign the scleral and conjunctival openings. The main purposes of the cannula are to maintain the misalignment of these openings to facilitate self-sealing closure of wounds after cannula removal and to allow repeated access to the small sclerotomies. Also, the cannula system allows interchangeability of the instruments and the infusion line between entry sites and protects the vitreous base from surgically induced trauma at the entry sites. The cannula may be closed with a fitted plug that has a hub for fixation to allow insertion and removal. The infusion cannula is a metallic tube with an inner and outer diameter of 0.37 and 0.56 mm, respectively, which allows for insertion into the microcannula. Since the original description, this cannula system has been modified with improvements in trocar design and sharpness, which allows for easier cannula placement. This system utilizes an electric guillotine action vitreous cutter with a maximum rate of 1500 cuts per minute (c.p.m.). Following this original system, other 25-gauge vitrectomy systems have been introduced. The most widely available alternative systems are similar in the fundamental design of the microcannulae but use a pneumatic vitreous cutter with a maximum rate of 1500 c.p.m. (Alcon, Ft Worth, TX, USA) (Dutch Ophthalmic, Holland).[7] For all of the systems, a variety of forceps, illumination probes, scissors, picks, and laser probes are available.

During the development and early use of the initial 25-gauge systems, suboptimal illumination was a major problem. This problem has now been eliminated with the use of xenon-based illumination systems, which provide excellent illumination through light probes or separate chandelier illumination devices.[8] The xenon-based illumination systems allow illumination and safety comparable to that achieved with 20-gauge systems.[9]

The suggested advantages of 25-gauge transconjunctival sutureless vitrectomy are shorter surgical time, less postoperative inflammation, faster visual recovery, and improved patient comfort. The key to obtaining these advantages is case selection. For relatively straight forward cases such as macular pucker, macular hole, and non-clearing vitreous haemorrhage, there is some evidence from small case series for shorter operative time, compared to 20-gauge surgery.[4] Other case series suggest faster visual recovery and improved patient comfort.[10,11] Rizzo *et al*[12] analysed 46 patients with idiopathic epiretinal membrane and compared a transconjunctival sutureless 25-gauge approach (26 patients) to a standard 20-gauge approach (20 patients). They measured operating time, surgical complications, postoperative inflammation, postoperative discomfort, and visual outcome. In the 25-gauge group, there was shorter operating time, less postoperative inflammation and discomfort, and more rapid visual recovery. Other studies also demonstrate more rapid visual recovery perhaps due to decreased postoperative inflammation and less postoperative corneal change.[13–17]

The apparent shorter operating time with 25-gauge vitrectomy is primarily due to the advantages of the transconjunctival approach, which saves time related to conjunctival opening, haemostasis, sclerotomy formation and subsequent sutured closure, and conjunctival closure. These advantages are diminished in cases requiring conjunctival opening for other reasons such as scleral buckling or in longer cases requiring extensive vitreoretinal dissection. The smaller diameter of the 25-gauge vitrectomy probe results in altered fluidics with less maximum flow through the probe compared to high-speed 20-gauge probes.[7] This results in longer vitrectomy time to remove an equivalent amount of vitreous. A recent randomized prospective study compared 25- and 20-gauge vitrectomy surgery and found a shorter duration of wound opening and wound closure with 25 gauge. However, there was no difference in total surgical time due to prolonged vitrectomy time for 25 gauge.[18]

Some surgeons believe that the diminished flow of the 25-gauge probe is an advantage that provides more stable fluidics and minimizes cutter-induced motion of detached retina, which facilitates safer peripheral vitrectomy.[7] The smaller probe size and decreased flow may also allow more precise dissection of preretinal proliferative tissue compared to 20-gauge cutters. As a result, some surgeons have expanded their case selection to include more complex cases such as traction retinal detachment. The use of silicone oil in 25-gauge vitrectomy remains problematic and usually requires enlarging one sclerotomy to infuse the silicone oil.

The small wound size of 25-gauge vitrectomy facilitates incorporation into anterior segment procedures such as simultaneous phacoemulsification surgery and glaucoma surgery.[19,20] By minimizing conjunctival damage, 25-gauge vitrectomy is ideal for eyes with filtration blebs. While many surgeons accept the above advantages of a 25-gauge system, a variety of potential complications have been described. These include the complications inherent to all vitrectomy surgery including retinal break formation, retinal detachment, and cataract.[21,22] At present, there is no definitive data to determine a difference between 20- and 25-gauge vitrectomy for these complications.

Hypotony, secondary to a wound leak, is a potential complication almost unique to sutureless vitrectomy. The reported incidence of postoperative hypotony ranges from 4 to 20%.[17,23] In most cases, the hypotony and any associated choroidal detachment resolve spontaneously in a few days. Techniques to avoid postoperative wound leakage and hypotony include a partial fluid-air exchange and intraoperative suture closure of any apparent leaking sclerotomy site. More recently, a bevelled incision with the trocar has been shown to decrease postoperative hypotony.[16]

Another complication inherent to any vitrectomy procedure is endophthalmitis. The transconjunctival nature of 25-gauge vitrectomy and the potential for hypotony have raised the question of whether there is an increased risk of endophthalmitis associated with 25-gauge vitrectomy.[24,25] As with the other complications inherent to any vitrectomy surgery, there is no definitive data to demonstrate an increased risk of endophthalmitis with 25-gauge vitrectomy. However, the extremely low baseline rate of endophthalmitis in vitrectomy surgery makes such a determination difficult. A recent report from the Wills Eye Hospital at the 2006 American Academy of Ophthalmology raises some concern. In a retrospective review of 5498 20-gauge vitrectomy procedures, there was one case of endophthalmitis (0.018%) compared to seven cases among 3103 25-gauge vitrectomy procedures (0.23%), a 13-fold increase.[23] These data are troubling because one would expect the 25-gauge series to include less complicated cases. However, because such a retrospective study may have unrecognized confounding variables, a prospective registry of 25-gauge vitrectomy complications has been proposed.

23 gauge

In 2005, Eckardt[5] introduced the first 23-gauge (0.72 mm) vitrectomy system. In this report, he extolled the advantages of a transconjunctival sutureless 25-gauge approach, but identified the disadvantages of limited indications due to the increased flexibility of 25-gauge instruments. He proposed a 23-gauge transconjunctival sutureless vitrectomy system to address the issue of 25-gauge instrument flexibility. A 23-gauge instrument platform creates significantly stiffer instruments, which allows for better intraoperative eye movement and easier use of silicone oil. The original report emphasized the need for a 30–45° bevelled incision using a 23-gauge stiletto blade followed by a blunt inserter with a steel cannula. The conjunctiva is slightly displaced and stabilized with a pressure plate (Dutch Ophthalmic, Holland). As with 25 gauge, the infusion port may be moved to any of the cannulae. At the 2005 American Academy of Ophthalmology, Eckardt reported on 400 patients treated with this system and concluded that the instruments were comparable to 20-gauge instruments. Postoperative hypotony defined as intraocular pressure less than 8 mmHg occurred in two eyes, and two eyes (0.5%) developed endophthalmitis. In a more recent series, Fine *et al*[26] reported on 77 consecutive cases of 23-gauge transconjunctival sutureless vitrectomy. Two patients had hypotony on the first postoperative day and one patient required an intraoperative suture. The authors concluded that 23-gauge vitrectomy is effective for a variety of retinal indications with an acceptable safety profile.

As with 25-gauge vitrectomy, 23-gauge vitrectomy instrumentation has quickly evolved and competing systems have been introduced. One new system (Alcon, Ft Worth, TX, USA) utilizes a single sharp trocar pass to place a titanium cannula. This system utilizes a 2500-c.p.m. vitreous cutter with the cutting port displaced closer to the tip of the instrument than with a 20-gauge cutter. These features improve fluidic control and facilitate retinal surface dissection. The fluidic control of the 2500 c.p.m. 23-gauge probe approximates that of the 1500 c.p.m. 25-gauge probe because the higher cut rate further limits flow. The original Eckardt system has also evolved and now utilizes a single pass placement of the cannula. An additional new feature is the placement of a valve system over the cannula, which minimizes flow through the cannula when instruments are not within cannula and eliminates the need for cannula plugs. As with 25 gauge, xenon-based illumination systems with either light pipes or chandeliers provide excellent illumination.

Conclusion

The development of transconjunctival, sutureless 25- and 23-gauge vitrectomy systems provides surgeons with new options in the surgical treatment of vitreoretinal disease. For select indications, both systems can shorten operating time, hasten visual recovery, and improve patient comfort compared to 20-gauge surgery. However, for both systems, these advantages are diminished by scleral buckling and in prolonged surgeries. Also, neither

system can address the need for pars plana lensectomy or management of dislocated lens fragments and intraocular foreign bodies. Cases using silicone oil require enlargement of a 25-gauge sclerotomy, but can be managed with the 23-gauge systems.

We must recognize that our experience to date with sutureless 25- and 23-gauge vitrectomy remains preliminary. The benefits of shorter operating time and improved postoperative patient comfort are important, but represent short-term clinical outcomes. There still is no data demonstrating long-term visual benefit compared to 20-gauge surgery. We need larger series with longer follow-up to determine whether potential complications such as endophthalmitis occur with greater frequency with transconjunctival sutureless approaches. If so, we then must decide whether the apparent advantages of small-gauge vitrectomy warrant an increased relative risk despite a very small absolute risk.

Today, in my practice, I utilize 20-, 23-, and 25-gauge systems depending upon the surgical indications. For most posterior retinal disease including macular holes, epiretinal retinal membranes, and vitreomacular traction disorders, I prefer a 25-gauge approach. I find the rapid visual recovery, minimal operative trauma, and postoperative patient comfort impressive. For most complicated retinal detachments secondary to proliferative diabetic retinopathy, proliferative vitreoretinopathy, and ocular trauma, I continue to use 20-gauge surgery. Increasingly, I am impressed by the all around utility of 23-gauge surgery, which seems to combine the best features of 20- and 25-gauge surgery. Time will tell whether one size will predominate, but I suspect there will continue to be indications for 20-, 23-, and 25-gauge vitrectomy surgery.

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