

Improving Upon the Advantages of Small-gauge Vitreoretinal Surgery

A transparent PMMA cannula and other modifications are proposed for small-gauge vitrectomy instrumentation.

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Over the past decade, vitreoretinal surgeons have been quick to understand the unique advantages and improved safety profile of small-gauge compared with conventional 20-gauge pars plana vitreous surgery. This is exemplified by data from the Preference and Trends survey conducted annually by the American Society of Retina Specialists (ASRS), which revealed that, in 2004, 48% of respondents had never tried small gauge vitreous surgery but, by 2007, 80% had used it for certain cases.¹

Drawbacks of 20-gauge vitreous surgery include increased surgical time and patient discomfort owing to the necessity of closing the large 0.89-mm sclerotomies with sutures. In addition, formation of iatrogenic retinal breaks adjacent to the sclerotomies became more increasingly recognized, and this was attributed to increased vitreous base and retinal traction from repeated passage of instruments through an unprotected sclerotomy. To overcome this risk, the first cannula system was introduced for 20-gauge surgery by Machemer in 1985.² This approach was, however, not adopted by the profession, as the sclerotomies still needed to be closed using sutures.

THE MOVE TOWARD SMALLER-GAUGE INSTRUMENTATION

For almost 3 decades the standard approach to vitreous surgery was to use 20-gauge sclerotomies and corresponding instrumentation. Over the past decade however, a rapid transition to smaller gauge, sutureless, trans-

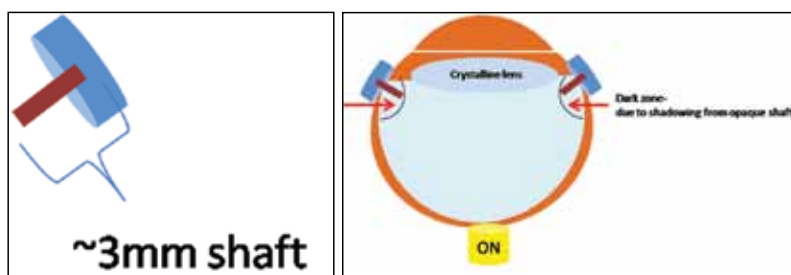


Figure 1. The overall length of the cannula shaft is approximately 3 mm, of which 0.5 mm is intrascleral and the remaining intravitreal (A). Drawing an arc with its center at the site of sclerotomy indicates that an area of vitreous 2.5 mm around the cannula remains in the shadow of the opaque shaft (B).

conjunctival surgery using 23-gauge, 25-gauge, and more recently, 27-gauge trocar cannula systems and instrumentation have emerged owing to contributions from Fujii, Eckardt, and Oshima.³⁻⁵ Current microincisional sutureless method, of vitreous surgery undoubtedly have reduced surgical time and improved patient comfort.

It was believed that by reducing vitreous base and retinal traction, the trocar-cannula approach would lower the incidence of sclerotomy-site-related iatrogenic retinal tear formation. Observations by Rizzo et al, Byeon et al and Ibarra et al, however, show that rates of retinal detachment following surgery with small-gauge (23-gauge and 25-gauge) instrumentation is no different from that using 20-gauge instrumentation.⁶⁻⁸ The most probable reason for this may be related to the relatively greater amount of residual vitreous remaining around the cannula inserted into the vitreous cavity during small-gauge surgery. The residual vitreous likely counters the advantage of reduced vitreous base traction at the sclerotomy site.

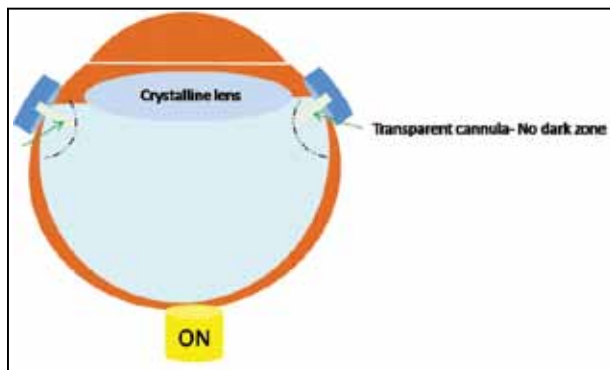


Figure 2. Transparent small-gauge cannulas made of PMMA would overcome the shadowing effect created around the sclerotomy site by the current opaque cannulas.

LACK OF VISUALIZATION

We believe that the prime reason for the subsclerotomy residual vitreous is the lack of visualization around the opaque intravitreal part of the cannula. Currently available cannulas used for small-gauge surgery are made of a hub and a shaft. The latter is made of either stainless steel or polyamide, both opaque in nature and not allowing any light transmission.

The shaft is composed of intrascleral and intravitreal sections. The overall length of the shaft is approximately 3 mm, of which 0.5 mm is intrascleral and the remaining intravitreal (Figure 1A). Drawing an arc with its center at the site of sclerotomy indicates that an area of vitreous 2.5 mm around the cannula remains in the shadow of the opaque shaft (Figure 1B). Although the cannula can be manipulated with its fulcrum at the site of entry, a significant amount of peripheral vitreous continues to remain in this shadow. Poor visualization around the cannula makes attempts to debulk or shave the vitreous in this region more hazardous, with associated increase in the risk of iatrogenic complications.

PROPOSED MODIFICATIONS

We suggest that 1 way of overcoming this limitation is by encouraging industry to develop cannulas that have a transparent shaft. An Ideal material for this purpose would be toughened PMMA or acrylic. Both these materials have been extensively used to make intraocular lens implants and have a proven track record for being biologically inert. PMMA also has excellent optical clarity and light transmission properties (92% transmission; 3-mm thickness, illumination D65, visible region 380 nm to 780 nm). Transparent small-gauge cannulas made of PMMA would overcome the shadowing effect created around the sclerotomy site by the current opaque cannulas. This would enable better visualization of the

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subsclerotomy vitreous (Figure 2), making it more amenable to easier and safer removal. With this modification, one may be able to truly take full advantage of vitreous base protection provided by small-gauge surgery and this could translate to reduced iatrogenic port site events.

OTHER ISSUES THAT REQUIRE ATTENTION

Some of the other issues that should be addressed with small-gauge systems are an increased intraoperative risk of subretinal/choroidal infusion, sudden hypotony from the disengagement of the infusion line from the cannula, and a greater difficulty in using self-retaining contact lenses. Currently available small-gauge infusion cannulas enhance the risk of subretinal/choroidal infusion because of its end-on design. The end-on leading edge of the cannula is more likely to drag any tissue ahead of it during the insertion of the trocar. This design also increases the complete movement of the cannula into the subretinal/choroidal space during significant globe movements or pull on the infusion line. This risk is likely to be reduced if 1 cannula is exclusively designed with a bevelled leading edge, as was the situation with traditionally available 20-gauge infusion cannulas.

Although there is a relatively tight fit between the hub of the infusion cannula and the infusion line, it carries an increased risk of disengagement even with lesser degrees of inadvertent pull on the infusion line. To overcome this risk, we suggest that the cannula for the infusion, aside from being bevelled, should also have a facility for a rotatory locking mechanism in conjunction with the infusion line. A velcro-like strapping tape that can be slid over the infusion tubing would also help keep the infusion line firmly bound down over the eye towel and reduce its inadvertent ripping out (usually by the assistant holding a contact lens) and associated sequelae (sudden, severe hypotony and, although a rare occurrence, serious intraocular hemorrhage).

Many vitreoretinal surgeons continue to prefer to use a contact-lens system for surgery. To use these lenses, one either requires an assistant to hold the contact lens carried on a handle or, alternatively, a self-retaining

design. The latter has 3 struts that abut along the curvature of the anterior sclera. These struts, however, are fixed rigidly to the circumferential ring and often the entire complex is made of 1 single piece. This rigid design causes the contact lens to easily shift off center, even with small movements of the eyeball during the operative process. Such shifts are more likely in small-gauge surgery due to the hub of the cannula. Lens' shifts can suddenly impair the surgeon's view of the vitreoretinal tissues, with associated risks. To overcome this limitation, we propose the design of contact-lens-holding platforms with self-correcting microhinges at the junction of the ring and the struts. Such microhinges would prevent transmission of eyeball movement to the optical center of the viewing contact lens.

SUMMARY

The currently available small-gauge instrumentation designs have certainly made vitreous surgery more efficient, comfortable, and safe. We believe, however, that current small-gauge instrumentation may not fully realize its full potential. Consideration of modifications, such as the introduction of transparent cannulas, a bevelled infusion line with a rotatory locking mechanism, binding down of the infusion line with a velcro-like strapping attachment, and self-correcting contact lens holders with microhinges, would be helpful to further the advantages and safety of small-gauge vitreoretinal surgery. ■

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