These tiny tools have important differences.

BY MICHAEL A. KLUFAS, MD

Every step in retina surgery is important and builds upon the previous one, which is why it is crucial to have the right instruments to ensure success. In the era of microincisional vitrectomy surgery, one perhaps seemingly trivial but extremely important tools is the trocar/cannula entry system. This article provides a comprehensive review of the systems available in the United States.

**THE PLAYERS**

Trocar/cannula entry systems are most commonly bundled with the vitrectomy packs to create an operating system. In the United States, these include the Constellation (Alcon), Stellaris PC (Bausch + Lomb), EVA (Dutch Ophthalmic USA) and VersaVit (Synergetics) systems. FCI Ophthalmics has also recently introduced a standalone trocar/cannula set intended for both routine and complex vitrectomy procedures. A summary of products currently available is provided in Table 1.

**LENGTH: IS BIGGER BETTER?**

Ensuring that the cannula is initially placed in the vitreous cavity can prevent complications such as choroidal detachment in complex cases with anterior loop proliferative vitreoretinopathy (PVR), thickened choroid, or history of ruptured globe. Although technique of entry—that is, using a straight-in entrance rather than beveling—may increase the chance of safe and successful surgery, cannula length also plays a role. Alcon manufactures 6-mm length 23-gauge and 25-gauge cannulas, both valved and nonvalved (Figure 1). These cannulas may be ordered individually or as a set of three for surgeons who wish to initially place a long cannula for the infusion, but use standard length for the remaining cannulas. This can be an important consideration, as longer cannulas may limit the surgeon’s ability to shave the anterior vitreous or perform an anterior base dissection.

A similar 6-mm length infusion line is available from Synergetics. In phakic patients, longer cannula length can potentially increase the risk of damage to the crystalline lens.

However, most often in cases for which long cannulas would be considered, the patient will already be pseudophakic or aphakic, or a lensectomy is planned. As for a violated lens or a subretinal or suprachoroidal infusion? Pick your poison.

FCI Ophthalmics offers the unique RetiLock cannula system, available in standalone packs of three, in valved and...
nonvalved varieties, and in 23- and 25-gauge configurations (Figure 2A). The trocar/cannula pack also includes an infusion line that is compatible with all vitrectomy platforms.

The RetiLock cannula has a circumferential autostable ring of increased diameter, designed to sit on the inner aspect of the pars plana (Figure 2B). The goals of this design are to increase stability and decrease the incidence of cannula dislocation during complex cases with multiple instrument exchanges.

The stakes can often be highest when the surgeon is at tamponade pressure during surgery for tractional diabetic retinal detachment, or when performing a retinectomy and attempting to achieve hemostasis. Dislocation of a valved cannula can lead to an open system that is no longer valved, resulting in increased flow, uncontrolled bleeding, and a real problem for the surgeon. Furthermore, after the cannula is removed, replacing it on the stiletto is an option, but it may continue to fall out with repeated instrument exchanges. In an era of increasing demands for efficiency, options such as the RetiLock system, Valved Cannulae in RD

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Abbreviation: MVR, microvitreoretinal
Note: 20-gauge systems are not included in this table but are available from Alcon, Bausch + Lomb, Dutch Ophthalmic USA, and Synergetics.
which keep the cannula in place, allow complex cases to move along as planned.

**VALVED VERSUS NONVALVED**

Although there is a trend toward the use of valved cannulas, some stalwarts remain loyal to nonvalved systems. Some surgeons who prefer to operate at higher intraocular pressures anecdotally assert that nonvalved systems decrease the incidence of intraoperative ocular ischemic events. Others have even told me, "I like to keep the evil humors running out of the eye." Surgeons who prefer long soft tips to check for the "fish strike" sign to confirm that the hyaloid has been removed may also prefer nonvalved cannulas, which allow entry of this type of instrument that would otherwise get caught passing through a valved cannula. To each his own, but for a large number of surgeons, the trend is moving toward valved cannula use.

The valve designs are external in products from FCI Ophthalmics, Dutch Ophthalmic USA, Bausch + Lomb, (Figure 3), and Synergetics; Alcon’s product has an internal valve. External valves have the benefit that they can be removed and replaced. This can be particularly helpful during removal of 5000 cs silicone oil via a cannula, allowing use of the entire lumen to remove viscous fluid quicker and more efficiently. Likewise, in order to place the new high-flow infusion lines from Dutch Ophthalmic USA (Figure 4; also, see below), the external valve must be removed.
External valves may be easily removed at the conclusion of a case to open the system for tamponade placement, whereas the internal valve system from Alcon requires the placement of an included vent or other instrument to allow egress of air. On the other hand, external valve cannulas typically have a larger outside diameter at the entry hub compared with internal valve models, which may limit the position and movement of a contact lens viewing system (AVI Lens).

**INFUSION LINES**

Dutch Ophthalmic USA’s two-dimensional cutter, or TDC, offers a stated duty cycle of 92% to 100%, allowing increased flow regardless of cut rate. To mitigate concerns that traditional infusion lines will be unable to keep up with aspiration, Dutch Ophthalmic USA introduced an over-the-cannula high-flow infusion line available for 23-, 25-, and 27-gauge systems.

Synergetics offers a new cap-over infusion line for 23- and 25-gauge platforms (Figure 5) in which a trocar blade with a preloaded cap-over infusion on a nonvalved cannula is already in place and ready to go after the trocar blade.

**Figure 5.** The 25-gauge (left) and 23-gauge (right) cap-over infusion models from Synergetics.

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Lancet-blade Trocars Encounter Less Resistance

By Hakan Kaymak, MD

Transconjunctival 23- and 25-gauge trocar systems provide a self-sealing option, as the surgical wound seals and heals without sutures due to the small incision size. Most trocar inserts contain a sharp needle-like stiletto entry device that creates a linear or curved cut through the scleral wall. The outer segment of the trocar is generally cylindrical, so that the surgeon can pivot the surgical instrument into the globe.

Various parameters play a role in determining the amount of force that must be applied during the initial piercing process, including the sharpness of the tip of the trocar, the thickness of the sclera and rigidity of the scleral resistance, and the intraocular pressure of the patient’s eye. The initial puncture is accomplished when the distal end of the trocar needle tip applies enough pressure to cause the tissue structure to be displaced. The length and form of the cut performed may influence the amount of dilation force and friction force needed.

In a clinical study, the cutting profiles and geometrical contours of 11 different 23-gauge trocar systems were analyzed, and the penetration forces were measured. The study found that the most important factor in reducing the penetration forces required was related to the design of the edges on the bevel face. Lancet blades required remarkably low piercing and cutting forces, inducing a symmetrical wound architecture and linear wound apposition. The “sharpest” system tested in the study was the lancet-pointed needle from Oertli. This recently introduced system included a snap-on lock infusion line for more flexibility and a double-slotted sealing membrane. (The US Food and Drug Administration has not approved this system.)

Many vitreoretinal surgeons now prefer to use novel blades with improved surgical beveled geometries for 23- and 25-gauge transconjunctival vitreoretinal surgery. Using these novel blades, the surgeon creates a self-sealing surgical wound, first by directing the surgical blade substantially parallel to the eye surface, then redirecting the blade to follow the general curvature of eye globe, and finally redirecting the blade to enter the interior of the eye. Recently introduced beveled trocar blades represent significant improvements over earlier needle-style trocars. The bevel design appears to reduce the amount of mechanical force required to penetrate tissue and insert the trocar system. These innovations have led to less resistance as the blade enters the tissue, smoother trocar insertion, and more efficient wound closure with better healing characteristics.

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removal. The small opening in the polymer cap that previously housed the trocar blade self-seals, or a 29-gauge chandelier may be placed through this opening without significantly compromising flow (Figure 6). Aside from the efficiency benefits of eliminating the step of placing the infusion line, the oblique design of the infusion line allows it to be positioned ergonomically without the bending and torque associated with securing traditional infusion lines. However, a drawback is that, given the design of this system, it may be more difficult to switch the infusion to a different cannula, particularly if the other cannulas are valved.

**PEDIATRICS: KIDS ARE NOT JUST SMALL ADULTS**

The anatomic proportions of pediatric eyes, particularly those of neonates, call for modification of standard trocar/cannula systems. Neonatal eyes differ in more than just size: the pars plana is not fully developed (hence, pars plicata vitrectomy), the crystalline lens is proportionally larger in relation to the vitreous volume compared with adult eyes, and the sclera can be thick and rigid. Alcon's 25-gauge short system includes a 3.2-mm sew-in infusion and 25-gauge microvitreoretinal, or MVR, blade, with scleral plugs to allow (Continued on page 15)

**TABLE 2. COMPARISON OF STANDARD AND PROPOSED PEDIATRIC INSTRUMENTS FROM DUTCH OPHTHALMIC USA**

<table>
<thead>
<tr>
<th>Cutter length</th>
<th>Light pipe</th>
<th>Trocar length</th>
<th>Cannula length (from base of flange)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>33 mm (23-gauge)</td>
<td>30 mm (all gauges)</td>
<td>10.3 mm</td>
</tr>
<tr>
<td>28 mm (25- and 27-gauge)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediatric</td>
<td>21 mm</td>
<td>21 mm</td>
<td>8.65 mm</td>
</tr>
</tbody>
</table>

Note: Pediatric instruments are under design, and measurements are for current models.
increased anterior access, which might be limited by placement of a standard cannula. Alcon’s 25-gauge short system is also compatible with Alcon 25 valved and nonvalved cannulas.

Synergetics offers a 3-mm pediatric cannula set with a 1-mm shorter Stealth trocar entry blade, as well as a pediatric-specific irrigating infusion cannula. Dutch Ophthalmic USA is developing a 27-gauge pediatric vitrectomy pack that will have 3-mm cannulas (instead of the standard 4-mm), with a trocar blade that has been reduced in length from the standard 10.3-mm to 8.65-mm (Table 2). Similar to Alcon’s 25-gauge short system, the Dutch Ophthalmic USA 27-gauge system will also feature a reduced-length vitreous cutter.

DOES IT REALLY MATTER WHAT KIND OF CANNULA I USE?

No system is perfect, but the designs and attributes of different trocar/cannula systems ultimately influence their function and utility (Figure 7). For routine cases, the nuances of the different products are unlikely to hinder or help achieve a good surgical outcome. Nevertheless, a neonatal detachment secondary to retinopathy of prematurity with distinct ocular anatomy and anterior tractional forces may become frustrating or impossible with a standard adult entry system. For proliferative vitreoretinopathy and other complex cases requiring infusion of perfluorocarbon liquid or multiple instrument exchanges, a valved system and the stability of FCI Ophthalmics’ RetiLock cannula may be advantageous. The cannulas are a small but important part of the instrumentation for pars plana vitrectomy, and the right choice can make your case run more smoothly and safely.