HIGHLIGHTS FROM THE
“FASTER AND SMALLER” SYMPOSIUM

A Video Presentation of the New Surgical Techniques Symposium in Tokyo

Sponsored by Alcon
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Advanced Vitreoretinal Surgery With Faster Cut Rates and Smaller Gauges

BY PRAVIN U. DUGEL, MD

When I started as a retinal surgeon, we did not have many choices regarding instrumentation and speed. I was given a cutter that performed at 400 cuts per minute (cpm) and was told, “This is what you use.” As retinal surgeons, the cut rate and gauge are important parameters to consider. I discuss my thought process regarding those parameters herein.

ULTRA-HIGHSPEED CUT RATE

I choose to remove vitreous gel with the fastest cut rate available, because research shows that a faster cut rate creates the least amount of traction when removing vitreous. The vitreous traction can be calculated with this formula:

\[ \text{length (of pull of the collagen fibrils)} = \frac{\text{flow rate}}{\text{lumen area/cut rate}}. \]

If the length of pull of the collagen fibrils is shortened, then traction is lowered with a higher cut rate. Therefore, reducing vitreous traction lowers the risk of causing a tear. Faster cut rates translate into a shorter length of pull of the vitreous, and thus less traction, regardless of the distance from the port of the cutter.

In the era of spring-based vitreous cutters, ultra high-speed cut rates were not always achievable, and when they were, there was little control over flow; when flow is reduced, the surgical efficiency declines. With modern dual-pneumatic cutters, however, duty cycle control is maintained. I have more surgical confidence with dual-pneumatic cutters because I know flow rate will not decrease intraoperatively with an ultra-highspeed cut rate.

CHOOSING AN APPROPRIATE FLOW RATE

Having a very high flow may not always be desirable; it may increase the risk of retinal tears due to amplified vitreoretinal traction (Figure 1). Flow rate is an important but misunderstood surgical parameter. Many surgeons believe the higher the flow, the better, but that is not necessarily the case. Instead, surgeons should think in terms of achieving appropriate flow. That means when one is working with a detached retina, the flow should be low enough to avoid or prevent inadvertent incarceration. When one is working away from the retina, perhaps performing a core vitrectomy, a higher flow rate would be appropriate. Surgeons sometimes confuse flow with acceleration (the rate of rise of flow). It is acceleration, not flow, that helps with the deformation and removal of pathologic tissue, such as retained lens material and thick fibrous tissue.

THE BENEFITS OF SMALLER INSTRUMENTATION

Another key factor in advancing modern retina surgery is the advent of small-gauge instrumentation.

I was involved in a study that demonstrated that large-gauge cutters require more flow for tissue retraction. My colleagues and I found that when the distance between the cutter and tissue was kept constant, generating tissue...
attraction required almost twice as much flow with a large-gauge cutter compared with a small one. This principle has been reported with 20-gauge, 23-gauge, and 25+ instrumentation, and it also applies to 27+ instruments (Figure 2). I have coined the term sphere of influence to describe this important effect (Figure 3). It can crudely be thought of as “collateral damage.” Sphere of influence, in effect, describes the region around the port influenced by fluid dynamics. Our study found that the sphere of influence on surrounding tissue was greatest with large-gauge vitrectomy probes. The smaller the sphere of influence, the more precise the surgery will be with the least amount of “collateral” damage.

Here’s another way to understand this concept in terms of gauge selection. We want to precisely remove fibrous tissue during an operation, but we do not want retinal incarceration. If the sphere of influence is large, we will be “imprecise” and risk retinal incarceration (collateral damage). With small-gauge surgery, we can precisely remove pathologic tissue without causing incarceration (minimal risk of collateral damage).

I choose to operate with the smallest possible gauge. I currently use the Ultravit High Speed 25+ Probe (Alcon), and when the 27+ becomes available, I will use it. The Ultravit High Speed 25+ Probe allows increased access to tissue planes, but with a small sphere of influence. The combination of the highest cut rate available with the smallest gauge available allows me greater precision. In other words, smaller gauge instruments designed efficiently can help achieve better performance than large-gauge probes while offering improved fluidic precision and safety.

**CASE EXAMPLE**

The value of 27+ instrumentation can be demonstrated with a surgery I performed on a patient with a rhegmatogenous retinal detachment. Because the cutter was very small, I was able to maneuver between tissue planes without a lot of manipulation. The cutter’s small sphere of influence allowed me to remove fibrous tissue very precisely without fear of incarceration.

A common misperception with smaller probes is that surgery will take longer. In this case, I was able to execute the entire case with 1 instrument and remove the tissue precisely, because the sphere of influence was small. I was also able to finish the entire surgery without taking the cutter out of the eye. At the end of the day, it is not about speed, but about efficiency. There is a great deal of efficiency in being able to remove pathologic tissue precisely without multiple exchanges of instruments.

**CONCLUSION**

The stiffness of 27+ instruments has not been a concern for me. In fact, these instruments are designed with a strut to enhance the stiffness. Overall, the advantages provided by small-gauge instruments in terms of precision and control outweigh flexibility concerns, in my opinion.

The 27+ technology is designed to offer surgeons the following: (1) exceptional access to small tissue planes; (2) efficiency, with use of the probe as a multifunctional tool with appropriate flow; and (3) precision, as the reduced sphere of influence will allow enhanced control. I have had the opportunity to use all of the gauges available, including 27+. When the 27+ instrument becomes available, I am convinced that I will use it for all of my cases.

1. Abulon DJ, Buboltz DC. Porcine vitreous flow behavior during high-speed vitrectomy up to 7500 cuts per minute. Poster A224. Presented at: ARVO; May 6-9, 2012; Ft. Lauderdale, FL.
Modern surgical equipment allows retina surgeons to take new approaches to complex surgery. Some believe that small-gauge vitrectomy is ideal for simpler cases, such as biopsies, endophthalmitis, and vitreous floaters, but not for complicated cases. However, that notion misses the point.

Smaller-gauge surgery with 27-gauge instrumentation has several advantages (Figure 1). The smaller opening can aspirate on the surface of the retina for delicate peeling. The high cutting rates possible with 27-gauge instrumentation allow the surgeon to shave tissue from the surface of the retina with less need for bimanual dissection. Another advantage of 27-gauge instrumentation is that the smaller probe can fit into very tight spaces between membranes, allowing for more control when peeling tissue.

**MANAGING COMPLEX CASES WITH SMALLER PROBES**

The Constellation Vision System (Alcon) allows the vitreoretinal surgeon to perform small-gauge maneuvers that were not possible in the past. It is capable of high-speed cutting rates of 7500 cuts per minute (cpm), which means the surgeon can shave the retina with minimal movement of the tissue underneath. The advanced fluidics of the Constellation offer high surgical efficiency and allow the surgeon to essentially erase the vitreous and shave abnormal tissue with minimal turbulence.

The 27+ probes available with this system allow for unique approaches to complex cases. For instance, both 25+ and 27+ instruments can be inserted between tissue planes to dissect and shave tissue from the surface of the retina, which may be particularly advantageous in diabetic cases and cases of rhegmatogenous retinal detachment. Suction can be used to lift the tissue slightly, and then the cutter can remove it. Because the cutter is designed with the opening very close to the tip, the surgeon can easily remove large sheets of tissue in an efficient manner, minimizing traction on the detached retina and possible iatrogenic breaks.

Some of the new techniques that can be performed with 25+ and 27+ vitrectors with the Constellation Vision System include the delamination of fibrovascular tissue, back cutting, back shaving, and erasing membranes from the surface of the retina with minimal movement of the underlying retina because of decreased traction and decreased sphere of influence.

**EXPERIENCE WITH 27-GAUGE INSTRUMENTS**

I first used 27+ instruments during a retinal detachment in a pseudophakic patient (Figure 2). I removed some of the vitreous behind the lens. With suction, I used the 27+ instrument as though it were forceps to remove part of the posterior hyaloid in an elegant, controlled manner. Afterward, I was able to lift part of the vitreous from the surface and maneuver the instrument under the tissue to...
SHAVE IT. In the past, I would have used viscodissection and created space between the abnormal tissue and retina in these types of cases; however, I think it is possible to perform the entire surgery with the probe. With 27-gauge, however, the probe is small and can perform as a blunt dissector, so fibrovascular tissue removal can be performed expeditiously.

Another technique that is possible with the 27-gauge probe became evident when I operated on a phakic eye with an epiretinal membrane. It surprised me to see how quickly I could remove the vitreous using maximum aspiration and cutting speed. I injected triamcinolone to visualize the vitreous and the posterior hyaloid, and then I lifted the epiretinal membrane and peeled it with suction, all without the need of forceps. It was very easy to lift both the posterior hyaloid and epiretinal membrane with significant control. Once the epiretinal membrane was removed, dye was injected to stain the internal limiting membrane, and the vitrectomy probe was utilized to peel the internal limiting membrane with minimal trauma to the underlying retina.

SYSTEM FEATURES

The Constellation Vision System has been engineered to allow for high cutting rates with maximum flow through the system. The 27+ vitrector can be used at 7500 cpm with practically the same flow as the 25+.4,5 The smaller probe can fit under spaces between membranes, and the smaller opening allows for more control when peeling tissue. This smaller size also allows us to perform surgery through smaller incisions.

In the past, the 20-gauge probe was the only probe available; now surgeons have access to 20-, 23-, 25-, and 27-gauge probes. There is a full range of associated instrumentation, such as chandeliers with the 25-gauge, 27-gauge needles, and forceps and scissors. This armamentarium of equipment will allow retina surgeons to perform surgery with great precision and accuracy.

The dual-pneumatic 27+ vitrectomy probe allows the opening to be open most of the time. With spring-action cutters or single-pneumatic probes, the opening is closed 50% of the time. The opening on the 27+ vitrectomy probe is actually programmable so that surgeons can adjust the time the probe is open depending on what structures are being removed.

CONCLUSION

Smaller vitrectomy cutters have several significant advantages, and these become more evident in complex cases, such as in diabetic retinal detachments. In the future, it is very possible that we will perform very delicate and precise surgical maneuvers with the 27-gauge probe.

4. Abulon DJ, Dubolz DC. Porcine vitreous flow behavior during high-speed vitrectomy up to 7500 cuts per minute. Poster A224. Presented at ARVO; May 6-9, 2012; Ft. Lauderdale, FL.
5. Ray A, Abulon DJ, and Dimalanta RC. Intraretinal pressure and BSS flow rates at high vitrectomy probe cut rates. Poster A225. Presented at ARVO; May 6-9, 2012; Ft. Lauderdale, FL.
A recent study in Japan showed that more retinal surgeons are using 25-gauge systems for microincisional vitrectomies. In fact, in March 2013, 65% of Japanese surgeons were using 25-gauge vitrectomy compared with 30% who were using 23-gauge, while only 5% were using 20-gauge. The numbers show that surgeons are increasingly interested in small-gauge surgery.

27-GAUGE SYSTEMS

I have been involved in the development of the Ultravit 27+ system (Alcon). This latest iteration of surgical technology would not have been possible without previous developments in vitreoretinal surgery (Figure 1). Now, the era of 27-gauge instrumentation is upon us, and there is a full line of small-gauge instruments available (Figure 2). In my hands, the 27+ vitrectomy instrumentation is very efficient, and I use it in most of my surgical cases.

My colleagues and I conducted a study at our facility that included 31 eyes undergoing vitrectomy with 27+ instruments. No eyes required a transition to larger-gauge instruments during surgery, and all sclerotomies healed at the end of surgery without hypotony. Anatomic success was achieved in all surgeries, and 65% of eyes had more than a 3-line gain in postoperative visual acuity. We concluded that the 27+ system was effective and reduced concerns about complications associated with wound sealing related to selected cases (Figure 3).

The use of 27+ instruments is ideal for spontaneous wound closure. Our research found that compared with a 25+ cutter, the duty cycle of the 27+ cutter is 61% at 1000 cuts per minute (cpm) and 38% at 1500 cpm; it was equal to or better than those of the 25-gauge cutter (62% and 28%, respectively).

VERSATILITY

The Ultravit 27+ system is useful for many situations, including many challenging cases. The Alcon Ultravit High Speed Probe is a dual-pneumatic drive probe that provides efficient cutting up to 7500 cpm. The probe is designed to reduce pulsatile traction without fluidic compromise. This probe does not alter flow, and it maintains efficient vitreous aspiration compared with a 5000-cpm probe.

The 27+ system provides benefits for surgeries, including those involving diabetic eyes. Previously, surgeons had to use more complex instruments to complete...
surgery in these eyes, including horizontal scissors with special picks to remove the membrane. With a small port cutter, the Ultravit 27+ system becomes more functional. In our center, we use a small cutter to gently lift the membrane, separate it from the retina, and finally use the cutter-like scissors to remove the membrane. I believe the 27+ Ultravit has a wider application for much more challenging cases.

The 27+ Ultravit system can be used in a variety of surgeries, including macular surgery, nonclearing vitreous hemorrhage or opacity, diabetic retinopathy, primary retinal detachment, subretinal hemorrhage, and possibly with retained lens fragments and intraocular lens dislocations.

CONCLUSION

The newly developed 27+ Ultravit system has greatly improved the efficiency and functionality of vitrectomy surgery. The further development of 27+ instruments, such as chandelier fiber optics, is critical for further widespread use of this system.

1. Data on File. Alcon Laboratories, Inc., Fort Worth, TX.
3. Abulon D, Buboltz D. Porcine vitreous flow behavior during high speed vitrectomy up to 7500 cpm. Poster presented at: ARVO; May 6-9, 2012; Ft. Lauderdale, FL.

Figure 2. The full line of 27-gauge instruments offered by Alcon.

Figure 3. A study at our center demonstrated the feasibility of using 27-gauge instrumentation in a variety of surgeries.
Advantages of the Ultravit High Speed Cutter

BY KAZUAKI KADONOSONO, MD

As vitrectomy surgery becomes more commonplace, retinal surgeons need the most effective technology at their disposal. This enhanced activity is likely due to greater availability of improved technology and instrumentation, and a better understanding of ocular pathology.

HIGH-RATE CUTTING

Newer surgical instrumentation affords surgeons a higher cutting rate, which may lower the risk of peripheral retinal breaks and hemorrhages. After using both 25+ and 27+ vitrectomy cutters with a cut rate of 7500 cuts per minute (cpm) with the Constellation Vision System (Alcon), it is my opinion that the 27+ instrumentation allows me to maximize the system’s cutting-edge capabilities.

Because a higher cutting rate contributes to less turbulence in the vitreous, it allows for a more stable retina during vitreoretinal surgery and enhanced control (Figure 1). It is commonly believed that a higher cutting rate equates to less aspiration flow during vitrectomy. In actuality, the aspiration flow of the vitreous increases with a higher cutting rate. This is because the viscosity of the vitreous decreases when it is removed with a high cutting rate.

There has been concern about the decreased duty cycle of vitrectomy probes using a higher cutting rate. However, the Constellation has an adjustable duty cycle, so surgeons can choose between bias open, bias closed, or neutral, expanding the capabilities in the core and shave modes (Figure 2).

I still use a 25+ vitrectomy probe with 7500 cpm in a few circumstances; for instance, when it is necessary to bimanually remove a membrane in eyes with proliferative diabetic retinopathy or the peripheral vitreous in eyes with retinal detachment; to remove the posterior capsular membrane in eyes with an intraocular lens; and to trim the internal limiting membrane during the use of an inverted flap technique in eyes with a large macular hole.

CONCLUSION

In the near future, I foresee that high speed probes will be in the OR of every vitreoretinal surgeon.

1. Abulon D, Buboltz D. Porcine vitreous flow behavior during high speed vitrectomy up to 7500 cpm. Poster presented at the Annual ARVO Meeting, May 6-9, 2012; Fort Lauderdale, FL.
WOUND CLOSURE

Pravin U. Dugel, MD: Small-gauge instrumentation is recommended for wound closure. Can you give us some tips you have learned in the past few years using this technology?

Maria H. Berrocal, MD: I do everything related to wound closure with 25- or 27-gauge probes. With the 25-gauge probe, I like leaving a small amount of air at the end, because then I know the wound is closed correctly. With the 25-gauge, I rarely get fluid leakage. When I use 27-gauge, the wound closes beautifully, and the eye looks almost like nothing has happened to it. Patients love it and think I have great hands, but it really is the technology.

Dr. Dugel: I agree. With a 27-gauge probe, as with the 25-gauge, there are fewer problems with wound leakage because of the smaller incision. Nonetheless, this design is very useful, because now we have a linear cut. I still angle the incisions, however.

FLUIDICS AND INTRAOPERATIVE PRESSURE CONTROL

Dr. Dugel: Do you use intraoperative pressure (IOP) control in all cases, and how has that helped?

Dr. Berrocal: Yes, I do use it in all cases. I have been performing vitreoretinal surgery for over 20 years, and in the past, bleeding was common, and so I would raise the bottle height. But then I would have no idea what the IOP was. Many of these cases resolved, but then 2 or 3 years later, the patient had optic nerve damage and poor vision, and I was not exactly sure why this occurred.

In eyes with advanced glaucoma, I let the IOP drop very low, maybe even to 10 mm Hg or less. That way, I know I am not damaging the optic nerve.

SILICONE OIL

Dr. Dugel: How do you use silicone oil in complex cases?

Dr. Berrocal: I have not tried using it with the 27-gauge probes, but I always use it with 25-gauge ones. What is beautiful about the Constellation Vision System (Alcon) is that it allows you to perform simultaneous silicone injection and active aspiration, which is crucial if you are doing a direct silicone oil-perfluorocarbon exchange.

Kazuaki Kadonosono, MD: I have not done many cases with silicone oil and 27-gauge probes, but I will use silicone oil with 25-gauge probes.

ENVISIONING FUTURE INSTRUMENTATION

Dr. Dugel: What is an instrument you would like to get your hands on?

Dr. Berrocal: I would like an illuminated cutter. As a minimalist, I imagine I could conceivably do a simple case and use the other hand for all sorts of other things.

Dr. Dugel: I think we are on the tip of a surgical revolution as vitreoretinal surgery gets smaller and less invasive. The current innovations will really change everything we do. In 10 years from now, do you think we will be talking about smaller instrumentation?

Dr. Berrocal: That question makes me recall a meeting in 2004 in which everyone was arguing about how bad microincisional technology was. Someone said, “The ideas come first, and the technology will follow.” Considering that, I think the smaller instrumentation will become more rigid and will enable us to do more maneuvers. Although this is anecdotal, I think we are already achieving better outcomes with the emerging technology. Ever since I started using smaller instrumentation, I have not had to deal with dialysis, sclerotomies, or white optic nerves. In the future, I think the technology will get even better.

Dr. Kadonosono: I was the first surgeon in Japan to use 25-gauge instruments. Everybody criticized me for it initially, but it is now 5 years later, and times have changed. Taking this into consideration, I think 27-gauge probes may follow the same arc of adoption. There may be smaller gauges in the future, and it is hard to predict the future and imagine what will be available.
CAUTION: Federal law restricts this device to sale by, or on the order of, a physician.

Indications for Use: The CONSTELLATION® Vision System is an ophthalmic microsurgical system that is indicated for both anterior segment (i.e., phacoemulsification and removal of cataracts) and posterior segment (i.e., vitreoretinal) ophthalmic surgery.

The ULTRAVIT® Vitrectomy Probe is indicated for vitreous cutting and aspiration, membrane cutting and aspiration, dissection of tissue and lens removal. The valved entry system is indicated for scleral incision, cannulae for posterior instrument access and venting of valved cannulae. The infusion cannula is indicated for posterior segment infusion of liquid or gas.

The PUREPOINT® Laser is indicated for use in photoagulation of both anterior and posterior segments of the eye including:

- Retinal photoagulation, panretinal photoagulation and intravitreal endophotocoagulation of vascular and structural abnormalities of the retina and choroid including: Proliferative and nonproliferative retinopathy (including diabetic); choroidal neovascularization secondary to age-related macular degeneration; retinal tears and detachments; macular edema, retinopathy of prematurity; choroidal neovascularization; leaking microaneurysms.
- Iridotomy/Iridectomy for treatment of chronic/primary open angle glaucoma, acute angle closure glaucoma and refractory glaucoma.
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The FlexTip® laser probe is intended to be used with ALCON® 532nm laser systems.

Contraindications:

- Patients with a condition that prevents visualization of target tissue (cloudy cornea, or extreme haze of the aqueous humor of the anterior chamber of vitreous humor) are poor candidates for LID delivered laser treatments.
- The infusion cannula is contraindicated for use of oil infusion.

Complications: Corneal burns, inflammation, loss of best-corrected visual acuity, loss of visual field and transient elevations in intraocular pressure can occur as a result of vitreolaser medical treatment. Unintentional laser burns can occur if excessive treatment beam power or duration is used.

Warnings and Precautions:

- The disposables used in conjunction with ALCON® instrument products constitute a complete surgical system. Use of disposables and handpieces other than those manufactured by Alcon may affect system performance and create potential hazards.
- Attach only Alcon supplied consumables to console and cassette luer fittings. Do not connect consumables to the patients’ intravenous connections.
- Mismatches of consumable components and use of settings not specifically adjusted for a particular combination of consumable components may create a patient hazard.
- Vitreous traction has been known to create retinal tears and retinal detachments.
- The closed loop system of the CONSTELLATION® Vision System that adjusts IOP cannot replace the standard of care in judging IOP intraoperatively. If the surgeon believes that the IOP is not responding to the system settings and is dangerously high or low, this may represent a system failure. Note: To ensure proper IOP Compensation calibration, place infusion tubing and infusion cannula on a sterile draped tray at mid-cassette level during the priming cycle.
- Leaking sclerotomy may lead to post operative hypotony.
- Back scattered radiation is of low intensity and is not harmful when viewed through a protective filter. All personnel in the treatment room must wear protective eyewear, OD4 or above at 532nm, when the system is in Standby/Ready mode as well as during treatment. The doctor protection filter is an OD greater than 4 at 532nm.

Attention: Please refer to the CONSTELLATION® Vision System Operators Manual for a complete listing of indications, warnings, and precautions.

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Warnings and Precautions:

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- Attach only Alcon supplied consumables to console and cassette luer fittings. Improper usage or assembly could result in a potentially hazardous condition for the patient. Mismatch of surgical components and use of settings not specifically adjusted for a particular combination of surgical components may affect system performance and create a patient hazard. Do not connect surgical components to the patient’s intravenous connections.
- Each surgical equipment/component combination may require specific surgical setting adjustments. Ensure that appropriate system settings are used with each product combination. Prior to initial use, contact your Alcon sales representative for in-service information.
- Care should be taken when inserting sharp instruments through the valve of the Valved Trocar Cannula. Cutting instrument such as vitreous cutters should not be actuated during insertion or removal to avoid cutting the valve membrane. Use the Valved Cannula Vent to vent fluids or gases as needed during injection of viscous oils or heavy liquids.
- Visually confirm that adequate air and liquid infusion flow occurs prior to attachment of infusion cannula to the eye.
- Ensure proper placement of trocar cannulas to prevent sub-retinal infusion.
- Leaking sclerotomies may lead to post-operative hypotony.
- Vitreous traction has been known to create retinal tears and retinal detachments.
- Minimize light intensity and duration of exposure to the retina to reduce the risk of retinal photic injury.

ATTENTION: Please refer to the CONSTELLATION® Vision System Operators Manual for a complete listing of indications, warnings and precautions.

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