

# INNOVATIVE TECHNOLOGIES IN VITREORETINAL SURGERY

Highlights from a roundtable discussion held at the  
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**O**VER THE PAST 5 YEARS, VITRECTOMY technology has undergone a revolution. Higher-speed cut rates and dual dynamic drive (3D) technology have enabled vitreoretinal surgeons to perform with maximum efficiency. The technology features advanced vitrectomy probes that offer high cutting speeds for enhanced control. With the 3D technology, a surgeon can control flow by adjusting both the cut rate and vacuum via a customizable foot pedal. This feature allows the surgeon to focus on the patient's eye as he or she controls cut rate, vacuum, and flow with the pedal. Recently, a group of world-renowned ophthalmic specialists met to discuss 3D technology and its elements. The specialists also offered their opinions on high-speed cutting in various surgical approaches. Highlights from that discussion follow.

**Dr. Williams:** What are the primary advantages of high-speed cutting?

**Dr. Farah:** We have all had an opportunity to use this technology for some time, and we have all operated without it. When we first started performing vitrectomy, we used a cutting rate of 400 to 500 cuts per minute (cpm). At the time, we didn't realize how slow that rate was. The increased rate has given us much more control of the vitrectomy. It has greatly improved our technique and decreased

the rate of complications. The increased rate has been very good for core vitrectomy and excellent for peripheral vitrectomy. It has made a huge difference for the patient, too.

**Dr. Rizzo:** In Italy, I have coordinated an observational, prospective, multicentric study that is now evaluating the effectiveness, safety, and advantages of high-speed vitrectomy (2500 cpm) versus standard vitrectomy (800 cpm). During this study, patients affected by various vitreoretinal diseases underwent complete vitrectomy. Results from our study showed that high-speed vitrectomy significantly reduces surgical time, consumption of balanced salt solution (BSS®), and the number of instrument changes, because the high-speed cutter does not require the use of scissors or forceps to dissect membranes. Thus, the complication rate with high-speed cutting was lower.

High-speed cutting reduces the trans-orifice pressure variation that occurs with each port open/close cycle. As a result, surgically induced retinal motion decreases. Moreover, fewer instrument changes mean a lower risk of iatrogenic retinal breaks from tool entry and withdrawal. High cutting rates result in a decreased flow per port-opening cycle, less fluctuation in pressure, and a greater fluidic stability. At the same flow rate,

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high-speed cutting reduces iatrogenic tractions and increases vitreous chamber stability, allowing the surgeon to approach the retina safely and closely.

**Dr. Williams:** Have the high-speed cutters enabled you to approach tissue differently than you could in the past?

**Dr. Farah:** Yes, without a doubt. We can use the high-speed cutters much closer to the retina, and we can remove fibrovascular tissues. With this technology, we have to enter, leave, and reenter the eye much less frequently, and we have fewer complications at the entry site. High-speed cutting also speeds up the surgery. With the right technique, we can use this technology to remove tissue that's connected to the retina. There is a learning curve associated with it, but the technology is very good.

## IT'S AMAZING HOW CLOSE TO THE RETINA YOU CAN USE HIGH-SPEED CUTTING WITHOUT CAUSING A TEAR.

HUGO QUIROZ-MERCADO, MD

**Dr. Williams:** That learning curve is important. We now have a much better understanding of what we're doing in surgery. In the past, we often focused our attention on the suction and numbers on a gauge. In reality, we're trying to manage flow. There are numerous ways to do that. We now have technologies that allow us to control flow, vacuum, and cutting rates simultaneously. By affecting the duty cycle, we can titrate nicely and precisely control our cutting and the flow.

**Dr. Rizzo:** During vitrectomy, we work in a complex environment with varying viscosity, dealing with substances, such as vitreous, blood, BSS®, and attached and detached retina, with different densities. Using the high-speed cutters, I can manage these tissues without worrying about the sudden increase in the aspirating flow that occurs when aspirating BSS® after a dense material. This is important because most vitrectomy machines use a modified venturi pump that doesn't allow direct control of flow, which is dependent on the density of aspirated material and the cutting rate. In contrast, using a peristaltic pump with constant pedal depression decreases the gradient of pressure when aspirating less viscous material with the same flow. High-speed cutting can reduce the difference in aspiration flow due to fluid viscosity, thus enhancing the safety of a venturi pump.

**Dr. Williams:** How do you use 3D technology and high-speed cutters in your diabetic population?

**Dr. Quiroz-Mercado:** We saw a dramatic change on the learning curve of our fellows with the introduction of the 3D technology. In the past, when we only had linear aspiration and did not have the high cut rate we have now, accidents

relating to retinal damage were more common. The surgeon is also more independent with this technology, because it is no longer necessary to ask a nurse to change the parameters. In our hospital, we find that using 3D technology to dissect fibrotic tissue close to the retina surface reduces the risk of retinal damage. In certain cases of proliferative diabetic retinopathy, we could perform segmentation without the need of scissors. It's amazing how close to the retina you can use high-speed cutting without causing a tear.

**Dr. Rizzo:** With high-speed cutters, I use the stalk-chop technique and approach dense membranes directly with a vitrectomy probe, using minimal flow, a cut rate of 2500 cpm, vacuum of 0-40 mmHg, and infusion of 60 cc. Moreover, in the presence of dense hemovitreous or clots, my core vitrectomy is quicker. The 3D technology enables me to control all parameters by using the foot pedal.

**Dr. Williams:** How do you use this technology in the management of retinal detachment patients undergoing primary vitrectomy?

**Dr. Brazitikos:** In cases of detached retinas, the use of high-speed cutting produces less motion of the retina. We can approach this tissue more closely and safely remove the peripheral vitreous. Before high-speed cutting was available, I used a lot of perfluorocarbon liquid (PCL) in many cases of primary vitrectomy for retinal detachment to overcome the motion of the peripheral retina while trying to remove the vitreous. Today when we do primary vitrectomy with high-speed cutting, I almost never use perfluoro-N-octane or other PCLs. I also find it much easier to teach residents to perform safer removal of the peripheral vitreous with high-speed cutting.

**Dr. Williams:** What are the ramifications of using a low cut rate? When compared with a high cut rate, why is a low cut rate advantageous for very thick tissue, such as a lens?

**Dr. Quiroz-Mercado:** Generally, I use a low cut rate for lens removal. Its advantages relate to the deformability of the tissue that you're cutting. When you have very solid tissue-like lens material, you need more time for the port to be open so you can make your cut.

**Dr. Rizzo:** I only use a low cutting rate for a lens fragment or a soft dislocated/subluxated lens (such as in patients younger than 45 years with Marfan syndrome or following trauma). In other cases, I perform combo anterior phaco to preserve the posterior capsula. For a dislocated lens with a hardness greater than 2+, I use endophaco. Based on the unproven theory that reduced cutting rates allow tissue to enter the port between cutting cycles, many surgeons recommend low cutting rates to remove membranes and lens material. I believe that using low cutting rates increases the likelihood of fluid surge following elastic deformation through the port as a result of low port resistance.

**Dr. Williams:** How do you use the VGFI® technology?

**Dr. Quiroz-Mercado:** This is a very interesting system. With it, we have the ability to control intraocular pressure (IOP), mainly in cases where we must manage bleeding.

**Dr. Rizzo:** Whenever possible, I use VGFI® technology. In my experience, it plays a more crucial role in small-gauge vitrectomy.

**Dr. Williams:** Would it be of any value if we could measure the absolute pressure in real time?

**Dr. Farah:** I believe so, because you are never absolutely sure if there is any leakage or other variable that may influence the IOP. Sometimes we think we have done a great job, with good perfusion of nerve, and then we have some atrophy after the surgery. This may indicate that somehow, for a certain period of time during surgery, we lost perfect control of the eye.

**Dr. Rizzo:** It would be great. At present, we only know the value set on the machine, so we can have a leak or a delay in equalizing the pressure inside the eye with the set value. The possibility of measuring the absolute pressure in real time is also crucial for small-gauge vitrectomy.

**Dr. Williams:** At what pressure do you typically prefer to operate?

**Dr. Farah:** Usually, 30 mmHg. I use 60 or 70 mmHg when I need to avoid or control bleeding.

**Dr. Rizzo:** I also typically use 30 mmHg and 60 or 70 mmHg to avoid or control bleeding.

**Dr. Williams:** That's a good point. We have the ability to raise the pressure in anticipation of bleeding. We're all familiar with the difficulty that can accompany a large hemorrhage. Many times, removing those clots can be more difficult than performing the initial dissection was. An experienced surgeon can anticipate bleeding and raise the pressure, even for extended periods of time while completing the dissection, and then slowly lower it again. That approach lets the surgeon identify specific bleeders. Then he or she can have a laser or diathermy ready to go.

**Dr. Brazitikos:** It is necessary to know exactly what the pressure in the eye is. With the VGFI® system, we seem to be using less and less unnecessary diathermy today. And once the dissection has been completed, we can lower the pressure gradually. If we see some bleeding, we do some diathermy precisely on these bleeding sites.

**Dr. Williams:** Have you used this technology in severe cases of proliferative vitreoretinopathy (PVR)?

**Dr. Farah:** I don't usually use the 25-gauge system for PVR cases. I am more likely to use the 20-gauge system in those patients. I like to have more instrumentation available, and I find that it's faster and safer to use the 20-gauge system. When I do a retinectomy, I do diathermy first, not over the area where

I'm about to do the procedure, but over the main vessel that I am going to cut. Then I use scissors. If I have trouble doing a perfect retinotomy, I do a vitrectomy, using very low aspiration and a high rate to ensure good control of the tissue removal.

**Dr. Rizzo:** I use a 20-gauge high-speed vitrectomy cutter, because it reduces surgical time. I prefer to avoid the use of 25-gauge technology in severe PVR, as it results in a prolonged vitrectomy. Currently, the 25-gauge tools are too challenging and time-consuming to use to perform complete vitrectomy in severe PVR.

**Dr. Williams:** After you complete a retinotomy, do you typically remove the anterior vitreous base and anterior retinal flap?

**Dr. Farah:** Yes, I do. Although when I do the retinotomy, I try to do as much as peripherally as I possibly can. I prefer to partially remove the anterior retina. I don't think it matters if there is just a small, thin layer of anterior retina remaining.

**Dr. Rizzo:** Yes, I do as well.

**Dr. Quiroz-Mercado:** You can start removing the membrane either from the periphery or from the posterior pole. I prefer to start from the posterior pole, injecting PCL and pulling the membrane with the forceps. When I reach the peripheral retina, I perform relaxing retinotomy if the retina does not reattach. In such cases, I must identify and remove membranes either on the surface of or under the retina.

**Dr. Williams:** Do you find that you are now doing fewer buckles in your PVR patients with this technology?

**Dr. Quiroz-Mercado:** For most PVR cases, I recommend using a buckle. In severe cases, it may not be necessary.

**Dr. Brazitikos:** I try to start with a 25-gauge system in PVR cases, and I can withdraw mature membranes with 25-gauge forceps. I am also trying to start the membrane removal from the posterior pole. I gradually inject PCL and see if there is some residual traction. I ask the assistant to put some pressure on the sclera, and we see if we can balance this residual traction.

**Dr. Rizzo:** No, I don't. If I have to treat PVR, I usually associate a broad, encircling 4- to 7-mm band with 20-gauge high-speed extensive vitrectomy.

**Dr. Williams:** Do you tend to diathermize the major vessels first?

**Dr. Brazitikos:** Not always. Because you may have some hemostasis, and some of these vessels will not always bleed. Some bleed, and some do not. Sometimes you end up doing more diathermy than is necessary. If you have some bleeding after posterior capsule opacification, you can easily target these vessels and do some diathermy.

**Dr. Rizzo:** When I perform a posterior retinotomy, yes, I do. For a peripheral retinotomy, I don't. When dealing with a fibrovascular stalk, I prefer to avoid bleeding by using high

infusion-pressure values or exerting mechanical compression on the vessel with the tip of a blunt tool.

**Dr. Williams:** Are any of the staining techniques useful in PVR?

**Dr. Brazitikos:** I sometimes try staining to visualize some membranes that we cannot always see. In my experience, this enables us to see more membranes. I don't know why. But I don't think staining is useful in all cases.

**Dr. Quiroz-Mercado:** I often do staining of the vitreous as well as staining of membranes like the internal limiting membrane (ILM). To visualize the vitreous, I prefer triamcinolone, which helps us see the vitreous cortex at the periphery and posterior pole. In some cases, such as with highly myopic eyes, the use of triamcinolone is fundamental for observing vitreous remnants in the macula in the presence of staphyloma. To stain ILM, I use trypan blue. If it is not well visualized, I use indocyanine green (ICG). In rare cases I use triamcinolone to visualize the ILM.

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**Dr. Rizzo:** I find that chromovitrectomy is. I routinely instill triamcinolone to highlight the vitreous gel and the posterior hyaloid membrane at the periphery and at the posterior pole. I also stain epiretinal membranes with trypan blue and ILM using ICG.

**Dr. Williams:** How does the foot pedal work? What settings do you use?

**Dr. Farah:** I start with a high cutting rate and low vacuum, so I can maintain low flow. Pressing down on the pedal lowers the cutting rate and raises the vacuum. I believe this is a safer position. I usually start with 50 mmHg of vacuum, so I have more time before it starts to increase when I press the pedal. Using the pedal reminds me of driving my car. When I am in a riskier situation, close to the retina, I take my foot off the pedal. It's not the speed of the car that I'm reducing but the risk. How does taking my foot off the pedal lower the risk? I know that it decreases the aspiration and increases the cutting speed, and that, in turn, lowers the risk.

**Dr. Williams:** So it's intuitive? Just as when you let up on the accelerator of a car, you are more in control?

**Dr. Farah:** Yes, it's similar to using the accelerator on a car. When I take the pressure off the accelerator, I'm in a much safer situation.

**Dr. Williams:** As we discussed earlier, we need to understand that cutting and vacuum are interchangeable parameters that control flow, and that's what we do. Flow drives vitreous

movement, and our ability to control that flow gives us precision. This surgical equipment is so much easier to use than what we had in the past. As our instruments continually improve, it becomes more difficult for us as surgeons to comprehend their true capabilities. If a surgeon doesn't take the time to learn what this new equipment can do, he or she will never fully appreciate its advantages.

**Dr. Quiroz-Mercado:** I've noticed that young surgeons understand 3D well and take advantage of its technology. Some surgeons who are more familiar with the linear technology do not accept 3D until they have a good understanding of it and have practiced using it several times. Then they can see its advantages, which include safe cutting, retina stabilization, and a reduced need for scissors.

**Dr. Brazitikos:** It is much easier to realize these advantages when you are actually doing vitrectomy rather than talking or reading about it. Apparently, the third dimension of 3D control is flow. It is safer to start with high-speed cutting and lower vacuum. With this parameter setting, you can have less flow during surgery. This is safer when you first enter the eye and start working close to the retina. When you are doing high-speed cutting and the vitreous flow in the port is low, or the vitrectomy is taking too long, you step on the pedal and increase vacuum while decreasing the cut rate. This adjustment will give you more flow, so you can remove the vitreous faster. I find that this interplay between high- and low-speed cutting enables you to finish surgery faster and safer.

**Dr. Williams:** The take-home message seems to be that the surgeon is in control and can adjust these parameters to suit a specific case. It's an interesting approach. Why is the flow low with high cutting rates? With a high cutting rate, the port is open for a shorter period of time. I believe that the concept is called aperture limited flow. Basically, this means that at higher cutting rates, the length of time the port remains open is shorter than the time it is at lower cutting rates. This provides a second control of the flow. We can adjust the vacuum, which obviously affects flow, and we can also control the length of time that the cutting port is actually open. These controls give us further precision.

## SUMMARY

High-speed cutting provides surgeons with enhanced control of the vitrectomy and fewer complications. Surgeons can use the high-speed cutters much closer to the retina. 3D technology grants the surgeon more independence, as he or she can change parameters by stepping on a foot pedal. This feature also allows surgeons to manage flow simultaneously with the vacuum and cutting rates. Other surgical benefits include lower flow when working close to the retina and higher flow for faster core vitrectomy. Further, the 3D technology enables surgeons to concentrate on the patient's eye rather than on gauges and settings.

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