Necessity-Driven Innovation

A Personal Journey Toward Efficient and Controlled 27-Gauge Vitrectomy

By Mitrofanis Pavlidis, MD, PhD

The development of vitreoretinal surgery has always been closely linked to the balance between clinical need and technological progress. The introduction of small-gauge vitrectomy, particularly 27-gauge (27-G) systems introduced in 2009, exemplifies this interplay.[1] The concept that operating through a smaller incision would reduce surgical trauma, improve wound sealing, and lead to faster recovery was compelling. However, early clinical experience revealed a significant gap between theoretical advantages and practical performance.

In 2012, when I first used a 27-G system, I found core vitrectomy was slower compared to larger gauge systems. Peripheral vitreous shaving lacked efficiency and fluidity. The reduced inner diameter of the instruments and limited suction flow prolonged the procedure, and high flexibility of the instruments compromised control in more demanding cases.

Thus, I started on a quest aiming to develop technology that would deliver the advantages of minimally invasive surgery while maintaining – or even improving – the performance characteristics associated with larger gauge systems. In pursuing this goal, I began a long-term partnership with DORC that led to development of the first double cutting vitrectomy, the TDC, in 2012, and to the introduction of DORC TDC VELOCE in 2025 – a next-generation, high-speed cutter that delivers efficiency, stability, and control to vitreoretinal surgery.

Designing the DORC TDC VELOCE: a brief history

My collaboration with DORC benefited from the company's culture surrounding innovation that reflected willingness to rethink fundamental aspects of technology. Designing a more efficient 27-G vitrectomy cutter was the initial focus of my collaboration with DORC. Conventional guillotine cutters operated with a single port that alternately opens and closes. This mechanism inherently interrupts aspiration flow and creates dependency between cut rate and efficiency. With increasing cut rates, the duty cycle decreases, resulting in reduced effective flow – an effect that becomes particularly relevant in small-gauge systems where baseline flow is already limited. In addition, periodic movement of the vitreous in the closing phase induces traction and uncontrolled removal of vitreous around a detached retina.

Following several early concepts and design iterations (Figure 1), the idea of the Twin Duty Cycle (TDC) cutter emerged. Featuring a permanently open outer port and a second cutting opening within the inner blade, the TDC cutter maintains a near-continuous aspiration flow, largely independent of cutting frequency. This represented a decisive shift from a fluidics perspective since flow was no longer constrained by the cyclic opening and closing of a single port.

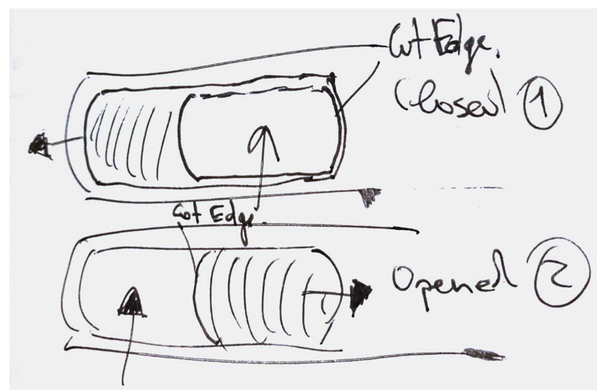

Figure 1. The first drawings of the Twin Duty Cycle (TDC) cutter.

Initial in vitro experiments demonstrated a substantial increase in aspiration performance compared to conventional cutter designs. These findings were confirmed in clinical application, where the improved flow translated into more efficient vitreous removal without compromising safety. As described in our initial TDC study, the concept established the principle that cutting efficiency and aspiration flow could be decoupled.[2]

Still, further refinement was needed if our goal was to develop a 27-G vitrectomy cutter that would match or even surpass the efficiency of larger gauge systems. Furthermore, we saw a need to increase rigidity to improve maneuvering.

We achieved our goals by creating the DORC TDC VELOCE. Its redesign includes changes in material, internal geometry, and tight dimensional tolerances to optimize flow dynamics and increase stiffness to approach that of 25-G instruments. Refinements were also made in the handpiece to enhance surgical ergonomics (Figure 2).

References: 1. Oshima Y. 27-G vitrectomy. Retina Today. April 2009. https://retinatoday.com/articles/2009-apr/0409_09-php. Accessed May 21, 2026. **2.** Pavlidis M. Two-Dimensional Cutting (TDC) Vitrectome: In Vitro Flow Assessment and Prospective Clinical Study Evaluating Core Vitrectomy Efficiency versus Standard Vitrectome. J Ophthalmol. 2016;2016:3849316. doi: 10.1155/2016/3849316. **3.** Pavlidis M, Steel DH, Oh H. Comparative flow and operating efficiency of TDC Veloce 27-G vitrectome. Retina. 2026 Apr 28. doi: 10.1097/IAE.0000000000004870. Epub ahead of print.

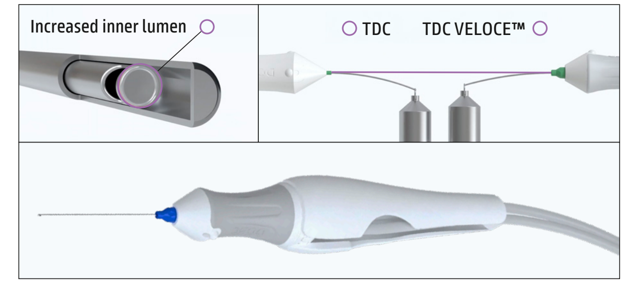

Figure 2. DORC TDC VELOCE

In in vitro and in vivo studies we found that compared to use of a standard 27-G 16,000 CPM TDC probe (DORC), the TDC VELOCE achieved markedly increased aspiration flow (typically by 30% to 60% depending on the medium) with higher cut rates of up to 20,000 cuts per minute (Figure 3).[3*]

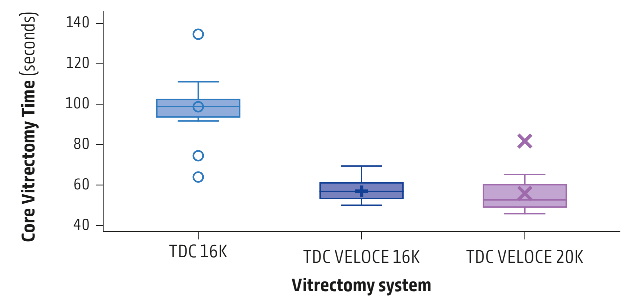

Figure 3. Core vitrectomy time comparing DORC TDC with DORC TDC VELOCE

Building an optimal system

The performance of a vitrectomy system does not depend solely on its cutter. Fluidics play an equally critical role, and it became clear that the full potential of the DORC TDC VELOCE concept could only be realized when combined with an advanced fluidic control system.

The DORC EVA NEXUS platform provides this complementary component through its VACUFLOW VTi pump, which fundamentally departs from traditional peristaltic or Venturi systems to deliver rapid, linear control of vacuum and irrigation and maintain anterior and posterior chamber stability. In addition, its SMART IOP technology (enabled by the TDC VELOCE for the posterior surgery) continuously regulates intraocular pressure by dynamically balancing inflow and outflow, allows to maintain a stable intraocular environment by compensating pressure losses and enhances surgical safety. To fully address the challenges of 27-G surgery, parallel refinements in illumination and instrumentation were required. Advances in LED technology compensated for the reduced diameter of 27-G light probes, while material and design improvements enhanced instrument stiffness and manipulation precision. In 2015, recognizing that absence of an efficient 27-G peeling forceps was a key limitation, I collaborated with DORC engineers to develop a 27-G wide grip forceps that offers broader tissue engagement, reduces the number of grasping maneuvers, and enables more controlled, efficient epiretinal membrane and internal limiting membrane peeling.

Hands-on observations

Clinical experience with the combined system highlights its advantages in several key scenarios. Increased aspiration flow improves posterior vitreous detachment induction in 27-G surgery and significantly reduces core vitrectomy time on eyes with dense, mixed liquefied vitreous. In addition, aspiration time and therefore total procedure time is significantly reduced during multiple steps, including fluid-air exchange and removal of perfluorocarbon liquids, membrane debris, or silicone droplets. Efficient stabilization of irrigation and aspiration makes it possible to operate at a physiological intraocular pressure of 20 mmHg without chamber instability, which protects the already vulnerable macula and optic nerve. During peripheral vitreous shaving, the combination of high cut rates and stable fluidics allows controlled work close to the retina. In more complex procedures, such as rhegmatogenous retinal detachment, improved chamber stability provided by SMART IOP technology of the DORC EVA NEXUS enhances safety during critical steps such as vitreous base removal and fluid management.

Integration of advanced surgical visualization technologies provides additional value. I am working with the ZEISS ARTEVO 850 3D digital ophthalmic microscope. I find that using its blue filters for vitreous and internal limiting membrane visualization in combination with the EVA NEXUS endolight with adjustable white-to-yellow illumination improves contrast and enhances depth perception facilitating precise and controlled tissue handling. This combination, especially when I adjust the endolight towards yellow, allows me to operate at significantly reduced light levels—often at 10% to 20% of conventional illumination. In conjunction with the efficiency of the DORC TDC VELOCE that shortens surgical duration, patients benefit from reduced cumulative light exposure and its associated risk of phototoxicity.

Concluding thoughts

Looking back, the development of the DORC TDC VELOCE was a direct response to a clearly defined clinical need. What began as a quest to overcome slow and inefficient 27-G vitrectomy evolved into a broader effort to rethink vitrectomy technology, so that 27-G surgery today offers the minimal invasiveness, efficiency, stability, and control that earlier systems lacked. This journey underlines a central principle: meaningful surgical innovation arises from continuous collaboration between clinical insight and engineering expertise – a process that is still ongoing.

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*The EVA NEXUS output can be controlled up to a maximum frequency of 10 000 cycles per minute. The maximum cutting speed of the pneumatic high speed vitrectome is effectively doubled to 20 000 CPM when a two-dimensional cutting vitrectome, like TDC VELOCE is used