Editorial

EJO European Journal of Ophthalmology

European Journal of Ophthalmology
2025, Vol. 35(6) 1953–1957

DOI: 10.1177/11206721251349248
journals.sagepub.com/home/ejo
Sage

Lessons from the vitreoretinal theater using the Beyeonics One™ surgical visualization system

Lorenzo Iuliano[1], Eleonora Corbelli[1], Francesco Bandello[1] and Marco Codenotti[1]

Abstract

In this editorial, we share our insights gained through extensive experience with the innovative Beyeonics One™ surgical visualization system across 48 diverse ophthalmic surgical procedures. We highlight its distinct advantages, such as enhanced immersive 3D visualization, ergonomic improvements, rapid autofocus, and innovative use of head gestures, as well as acknowledge its limitations including the learning curve, setup complexities, and cost considerations.

Keywords

Beyeonics one, 3D visualization, ophthalmic surgery, head-mounted display, digital surgery, augmented reality, surgical ergonomics, vitreoretinal surgery, cataract surgery

Date received: 1 April 2025; accepted: 26 May 2025

Editorial

The Beyeonics One surgical visualization system represents a significant innovation in ophthalmic surgery. Unlike traditional optical microscopes, it employs a fully digital platform, comprising a 3D head-mounted display (HMD), high-resolution stereoscopic cameras, and an integrated workstation.[1,2] This configuration allows surgeons to visualize the surgical field directly in an immersive, augmented reality environment. The HMD provides a real-time 3D view, freeing surgeons from the constraints of traditional oculars, while head gestures facilitate hands-free control of essential parameters such as zoom, focus, and illumination. These features promise enhanced ergonomics and precision, which are particularly valuable in complex ophthalmic procedures.[3,4]

The system's main components include:

- Head-Mounted Unit: offers high-resolution, stereoscopic imaging and incorporates motion sensors for intuitive control
- Camera Unit and Workstation: delivers 8 K resolution imaging with a semi-robotic arm for precise positioning
- Foot Pedal: complements head gestures with traditional foot-controlled adjustments.

Over the course of 48 surgical cases, we explored the system's capabilities across diverse procedures, including macular surgeries, retinal detachments, silicone oil removal, and combined phacovitrectomies. All procedures were successfully completed using the Beyeonics One™ system. There was no need to convert to a traditional optical microscope in any case.

This editorial aims to share insights into its advantages, criticisms, and practical tips for optimizing its use.

Advantages of the Beyeonics One™ system

Immersive visualization

The system enables surgeons to view the surgical field directly through the HMD rather than relying on a monitor.

[1]Department of Ophthalmology, Vita-Salute University, San Raffaele Scientific Institute, Milan, Italy

Corresponding author:
Lorenzo Iuliano, Department of Ophthalmology, IRCCS San Raffaele Scientific Institute, Vita-Salute San Raffaele University, Via Olgettina, 60 20132 Milan, Italy.
Email: iuliano.lorenzo@hsr.it

This creates a highly immersive experience, with superior depth perception and spatial orientation.[5,6]

Bifocality and transparency

The HMD allows for bifocality – the ability to simultaneously monitor the surgical field and the external environment. Additionally, its see-through functionality lets the surgeon disable the display and view the surgical site directly if needed.[7]

Enhanced training and collaboration

The pointer feature, controlled by the head-mounted unit, is invaluable for teaching. Senior surgeons can guide trainees with precise visual instructions, particularly during delicate macular surgeries.

Rapid autofocus

The autofocus option acts as an "emergency reset," quickly re-establishing clarity and focus. This feature is especially useful during transitions between anterior and posterior segment work.

Instantaneous adjustments

The digital nature of the system allows for rapid anterior-posterior changes, akin to flipping a switch. This eliminates the mechanical delays associated with optical systems, streamlining workflow.[5]

Ergonomics and comfort

The HMD weighs 600 g, with most of the weight located in the front display. Despite this, the perceived sensation is not that of a heavy or cumbersome device. In general, surgeon feedback described the system as allowing for light, fluid movements during surgery. By eliminating the need to hunch over oculars, the system significantly improves operator posture and comfort, reducing fatigue during long procedures. Surgeons can sit back and adjust their view seamlessly.[5]

In our experience, full confidence with the Beyeonics One™ was reached after just 3 to 4 procedures. The digital visualization is intuitive, with high image quality and no significant cognitive barrier. The actual learning curve lies in memorizing and integrating the new foot pedal positions used to activate head gesture controls into the surgeon's motor patterns. Once these gestures become natural, the system reveals its full potential in offering refined control and precise visualization.

Beyond technical performance, the sense of immersion, clarity of visualization, and ergonomic comfort positively impacted surgical fluency and overall satisfaction.

Criticisms and areas for improvement

Comparable surgery duration

Although the system enhances visualization and ergonomics, overall surgery times remain similar to those performed with traditional microscopes, as highlighted by Sorkin et al.[1] The learning curve – averaging around four cases in our experience – contributes to this.

Limited visibility in certain conditions

Hazy views in cases involving anterior chamber pathologies were occasionally reported. These limitations underline the need for further optimization of image quality under challenging conditions. We experienced one single case (full thickness macular hole), where the posterior pole could not be reached with a crystal and purely focused visualization. This has been related to a corneal decompensation.

Initial setup complexity

While the Beyeonics One™ system offers significant ergonomic and visual advantages, it requires careful and deliberate setup to ensure optimal performance and comfort. A critical step involves the precise adjustment of the head-mounted display (HMD). This process can be time-consuming, especially during initial uses, as it demands meticulous fine-tuning to achieve stable alignment, avoid pressure on the nasal bridge, and maintain consistent bifocality. An improperly adjusted headset may shift during surgery, cause discomfort, or result in intermittent loss of sharp focus – ultimately undermining the immersive visual experience.

In addition to physical setup, the digital system requires preoperative configuration of key parameters such as light exposure and depth of field. These settings significantly influence intraoperative image quality and must be calibrated based on the type of surgery, media clarity, and individual surgeon preference. Although these adjustments become more intuitive over time, the initial complexity may be perceived as a barrier to seamless integration into routine surgical workflow.

Cost considerations

As with any advanced surgical technology, the Beyeonics One™ system entails a substantial financial investment. This may raise concerns, particularly in centers where the perceived benefit may not yet fully justify the cost. However, it is important to contextualize these expenditures: the pricing is generally aligned with other high-end digital visualization platforms currently on the market. Moreover, investing in a system that significantly enhances surgeon comfort, posture, and visual control translates into

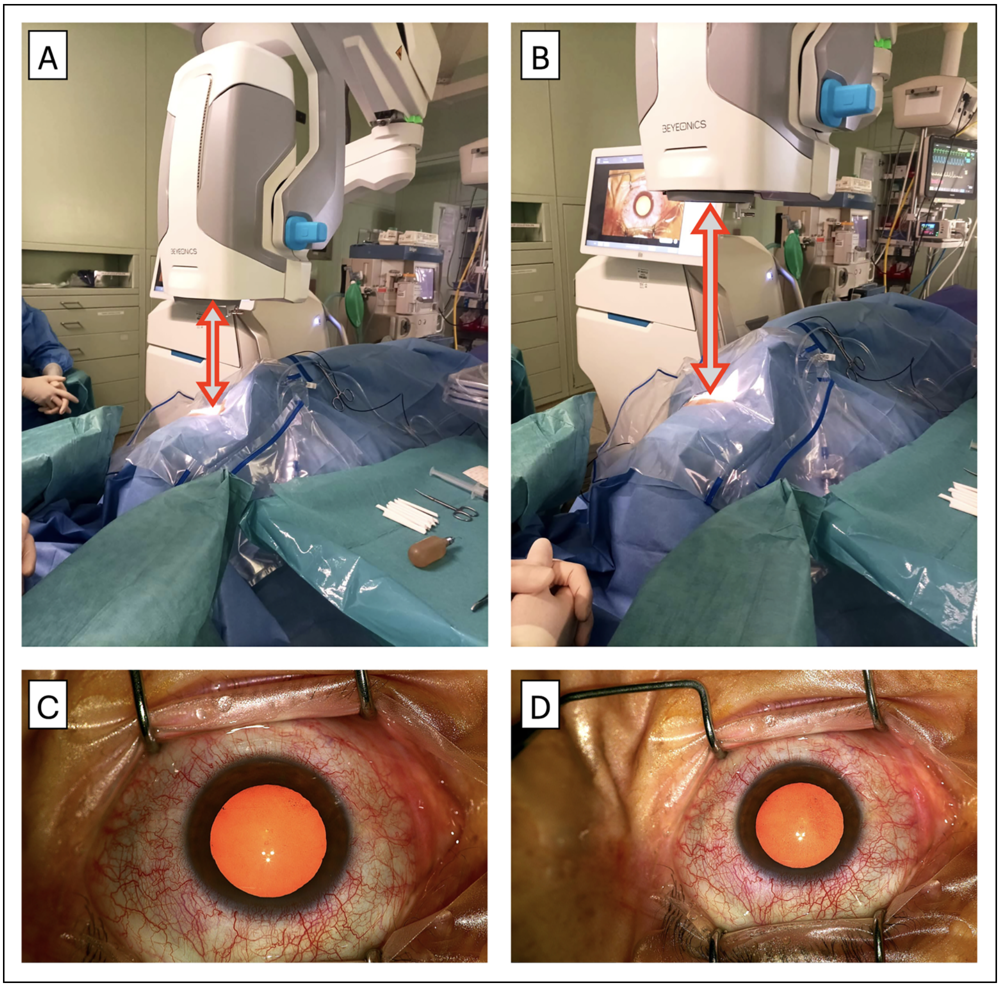

Figure 1. Depth of field management. A broader field of view (d), compared to the standard (a, c), is achieved by elevating the exoscope 35 mm from the operating field (b), followed by zoom augmentation and aperture size reduction. This setup enhances depth perception and facilitates tasks such as suturing and knot-tying.

higher procedural quality and long-term professional sustainability. In this sense, optimizing the working conditions of a highly skilled resource – the surgeon – may improve procedural performance and contribute to overall staff efficiency and satisfaction. Further studies evaluating cost-effectiveness across different surgical settings and procedure types will help clarify the broader economic value of such technologies.[5]

Practical tips for optimizing the Beyeonics One™ experience

Adjusting the HMD

Before donning the HMD in sterile conditions, pre-fit it in a non-sterile setting. The display should rest on the mid-dorsum of the nose – close enough for immersion but not so close as to cause pressure or restrict bifocality. Secure the helmet with the adjustable buckles once the display is aligned.

While the system remains comfortable during most procedures, extended surgeries – such as those for complex retinal detachments – may result in mild discomfort due to prolonged contact with the nasal bridge. This can be mitigated through careful preoperative adjustment of the headset, especially focusing on optimizing the nasal contact point to reduce pressure.

Managing depth of field

Maintain an eye-unit distance of 20 mm during surgery. For a broader field of view, increase this to 35 mm, then augment the zoom and reduce the aperture size. This setup enhances depth perception and facilitates tasks like suturing and knot tying (Figure 1).

Optimizing illumination

When working in the posterior segment, use a mid-to-closed aperture with minimal illumination. This

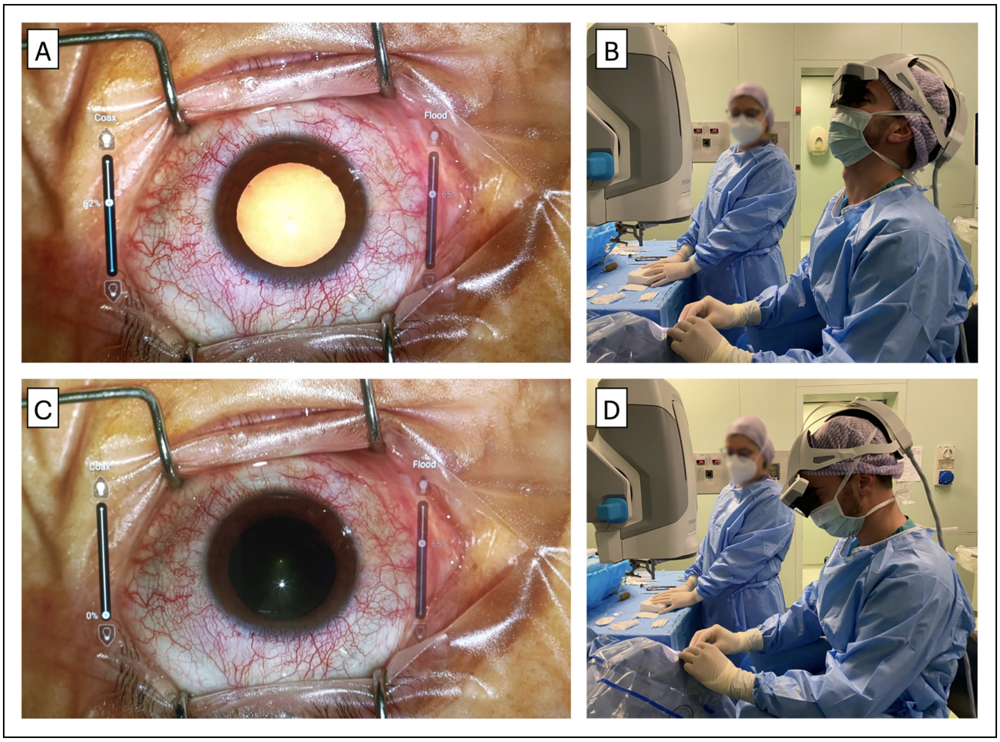

Figure 2. Head gestures to control lighting settings. Head gestures allow for faster and more precise adjustments compared to traditional foot pedal controls. The coaxial light (for red reflex enhancement) is increased with a "chin-up" gesture (a and b) and decreased with a "chin-down" movement (c and d).

configuration enriches vitreous contrast, mimicking the effect of triamcinolone staining, and minimizes retinal light exposure. For macular work, widen the aperture to enhance brightness and contrast.

Mastering head gestures

Learn to control zoom, focus, and light settings using head gestures. These adjustments are faster and more precise than traditional foot pedal controls. For anterior segment surgeries, the ability to quickly adjust coaxial lighting creates an enhanced visualization experience (Figure 2).

Ergonomic awareness

Take advantage of the ergonomic freedom offered by the HMD. During lengthy procedures like panretinal photocoagulation, sit back and maintain a relaxed posture. This reduces physical strain and enhances focus.

Light exposure management

Minimize light intensity whenever possible to reduce the risk of retinal phototoxicity. The system's high-resolution imaging compensates for lower light levels, ensuring adequate visualization without compromising safety.

Training and collaboration

Use the dual HMD feature for trainee instruction or collaborative surgeries. Take also advantage of the head-controlled arrow, to guide vectors and gestures of trainee especially during macular surgery. Observers can experience the same high-quality 3D view, improving educational outcomes.

Conclusion

The Beyeonics One™ surgical visualization system represents a transformative step forward in ophthalmic surgery. Its immersive 3D visualization, ergonomic advantages, and innovative features such as head gesture controls and bifocality elevate the surgical experience. However, its learning curve, initial setup challenges, and cost considerations warrant careful evaluation before widespread adoption.

Our month-long experience across 48 cases highlights its potential to redefine surgical standards. By adopting the tips and strategies outlined above, surgeons can maximize the benefits of this cutting-edge technology while addressing its limitations. With continued advancements and broader clinical adoption, the Beyeonics One™ system may well become the benchmark for digital ophthalmic surgery.

We are in the era of analog-to-digital transformation – much like when we initially missed the physical keyboards of old mobile phones, only to realize we can no longer live without full-screen devices.

Acknowledgments

The authors wish to thank the FIMAS srl for their valuable support in acquiring images from the surgical theater.

Consent to participate

There are no human participants in this article and informed consent is not required.

Consent to publication

Not applicable.

Data availability

Data sharing is not applicable to this article, as no datasets were generated or analyzed in the preparation of this editorial.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical considerations

This manuscript is an editorial providing commentary and practical insights regarding the use of an existing surgical visualization system. Therefore, no ethical approval or informed consent was necessary.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Lorenzo Iuliano https://orcid.org/0000-0001-6664-1327
Eleonora Corbelli https://orcid.org/0000-0003-1658-1922
Francesco Bandello https://orcid.org/0000-0003-3238-9682

References

1. Sorkin N, Levinger E, Achiron A, et al. Use of a three-dimensional head-mounted digital visualization platform in cataract surgery. *Eye (Lond)* 2023; 37: 2905–2908.
2. Schwartz S, Gomel N, Loewenstein A, et al. Use of a novel beyeonics one three-dimensional head-mounted digital visualization platform in vitreoretinal surgeries. *Eur J Ophthalmol* 2024; 34: 880–883.
3. Provencher LM. Minimally invasive glaucoma surgery (MIGS) using a 3D digital surgical ophthalmic exoscope. *Am J Ophthalmol* 2023; 249: e2–e3.
4. Gomel N, Levinger E, Lankry P, et al. Use of a novel three-dimensional head-mounted digital visualization platform in corneal endothelial transplantation. *Ophthalmol Ther* 2023; 12: 625–631.
5. Horigome Y, Iwashita Y, Hirono K, et al. Evaluation of the retinal hazard with 3D digitally assisted visualization system and conventional microscope in macular surgeries. *Retina* 2022; 42: 2301–2306.
6. Akiyama K, Watanabe K, Fukui M, et al. Quantitative evaluation of digital-image enhancement during heads-up surgery. *Sci Rep* 2019; 9. doi:10.1038/S41598-019-52492-Z
7. Eckardt C and Paulo EB. Heads-up surgery for vitreoretinal procedures: an experimental and clinical study. *Retina* 2016; 36: 137–147.