GETTING SPECIFIC ABOUT 3-D VISUALIZATION

An understanding of the features and benefits of this new technology is necessary to its successful implementation.

BY STEVE CHARLES, MD

Proper use of terminology is crucial when a new technology is introduced. The Ngenuity 3D Visualization System (Alcon) is no doubt an important advance in visualization for retina surgery, but several terms are being used loosely in relation to this technology. Yes, it provides 3-D visualization, but operating microscopes have featured dual oculars and stereo 3-D viewing since they were introduced more than 60 years ago; we are still looking for a compelling name for this new technology. Yes, it allows heads-up viewing, but tilt oculars have been available for operating microscopes for decades; there was no ergonomic problem to solve. On the contrary, in fact, the current system requires a slight turn of the head for the surgeon to see the properly placed surgical display screen, so this new technology actually introduces minimal ergonomic stress. When one considers these points, it becomes clear that use of the term *3-D heads-up surgery* to describe this technology is a misnomer.

Further, the term *digital visualization* has been used in reference to the Ngenuity system, and, although this is technically correct, the term addresses the implementation of the technology rather than its considerable clinical benefit. Understanding the difference between a feature (digital visualization) and a benefit (improved visualization) is important in assessing the value of a new technology.

This article explores some of the features and clinical benefits of the Ngenuity system.

IMPROVED DEPTH OF FIELD

Ngenuity uses a stereo pair of single-chip complementary metal-oxide semiconductor (CMOS) cameras and small controllable apertures, a combination that provides greater depth of field than a conventional operating microscope. Increased depth of field is the feature that enables the benefit: use of much greater magnification, enabling significantly better visualization. Ngenuity gives physicians the flexibility to adjust depth of field. Increasing the aperture area decreases depth of field.

GREATER MAGNIFICATION

Effective use of greater magnification requires attention to several specific details. Unless the patient is moving side-to-side or nodding the head, the image should vertically fill the 55-inch Ngenuity display. Use of less magnification defeats the purpose of 3-D visualization. On a 16:9 display, the circular image leaves space to the side for imported digital images, intraoperative optical coherence tomography (OCT), electronic health record (EHR) data, and Constellation Vision System (Alcon) parameters.

PRECISE FOCUS

Precise focus is essential to using high magnification. Focus must always be optimized at high magnification. At the start of surgery, focus should be at the plane of the cannulas, the site of introduction of the infusion cannula and tools. The infusion cannula must be inspected at high magnification to make sure non-pigmented ciliary epithelium, choroid, or retina is not stretched over the tip. As vitreous removal proceeds, focus should be moved down progressively. Ultimately, focus must be optimized on the retinal surface, always at very high magnification.

REDUCED ILLUMINATION

The high sensitivity single-chip CMOS camera pair enables use of much lower light levels than with standard

AT A GLANCE

- The Ngenuity 3D Visualization System provides increased depth of field.
- Precise focus is essential to using high magnification and must always be optimized.
- Viewing distance is crucial in using high magnification; the 55-inch monitor should be positioned 3 feet to 4 feet from the surgeon.

Photo courtesy of Alcon.

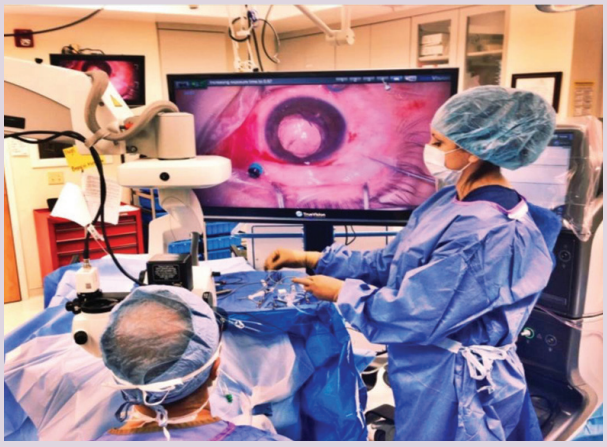

Figure. The 55-inch OLED display should be positioned 3 to 4 feet from the surgeon, as shown here. Because everyone in the room has the same view as the surgeon, the Ngenuity 3D Visualization System permits teaching opportunities and fosters coordination among surgical staff.

KEY BENEFITS OF THE NGENUITY 3D VISUALIZATION SYSTEM

- Better depth of field enables high magnification, even at the macula
- Lower light levels reduce phototoxicity
- Efficiency is increased because nurses, scrub techs, and anesthesiologists are engaged
- Teaching is improved because everyone can see what the surgeon sees
- Large screen allows data fusion:
  - Surgical parameters
  - Intraoperative OCT images
  - EHR data OCT, digital fundus images, digitized retina drawings

microscopy, typically 15% to 20% of maximum light level on the Constellation for vitrectomy and 1% to 5% for macular surgery. These lower levels potentially eliminate any question of light toxicity.

Light level should be constantly optimized by moving the endoilluminator closer to and farther from the target, especially during macular surgery. A longer endoilluminator working distance reduces light level and increases spot size on the retina. On the Constellation, surgeons can set the percentage of maximum light output at 1% to 5% for macular surgery, 20% for retinal detachment, and 25% for dense vitreous hemorrhage.

COLOR ADJUSTMENT

Color gains can be adjusted to augment contrast for particular situations. Alteration to make the image appear somewhat red enhances visualization of indocyanine green stain; this allows the surgeon to dilute the stain approximately tenfold. Adjusting color gains to make the image look yellow-orange enhances the faint staining of brilliant blue G stain. Reducing the red gain reduces the red reflex, making the image look blue and enhancing visualization of vitreous.

POSITIONING OF THE MONITOR

Proper viewing distance is crucial to use of high magnification. Ngenuity's 55-inch organic light-emitting diode (OLED) display should be positioned 3 feet to 4 feet from the surgeon (Figure). Use of a smaller display closer to the surgeon causes vergence-accommodation conflict. Accommodation-vergence conflict persists in surgeons who are presbyopic, so surgeons should use full distance correction with an additional +0.50 D because of the viewing distance. Several things should be pointed out: (1) This is *not* trifocal intermediate distance; (2) Progressive spectacles would require the surgeon to tilt the chin up; (3) Use of monovision contact lenses is not acceptable.

It is important to note that the surgeon does not need to accommodate in order to enjoy the large depth of field provided by this system. Accommodation fatigue can be avoided by maintaining steady distance accommodation.

One advantage for the surgeon of having the large display close by is that it allows him or her to use photopic, high-acuity vision rather than mesopic vision to look around on a large magnified image.

Note that, if an assistant surgeon holds the surgical contact lens, he or she must view the surgery through a stereo observer scope rather than through the 3-D system.

TEAMWORK MAKES THE DREAM WORK

In addition to its visualization benefits, the Ngenuity system also improves working conditions for all in the OR. It is ideal for enhancing coordination among the OR team and for teaching residents and fellows because everyone sees what the surgeon sees. As noted earlier, the extra space to the side of the surgical image on the display also provides room to project Constellation parameters and images or data from OCT and EHR. Some of the key benefits of the system are summarized in the sidebar above. ■

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