3D Visualization In Ophthalmology

New technology offers a "heads-up" way to perform surgery.

BY ROBERT J. WEINSTOCK, MD, AND ERIC D. DONNENFELD, MD

One of the most interesting and enjoyable aspects of cataract and refractive surgery is the opportunity to work with and evaluate new technology on a regular basis. Every year, the diagnostic and procedural equipment that we ophthalmologists use to improve our patients' vision continues to evolve. Phaco machines, microkeratomes, IOLs, laser platforms, aberrometers, and topography machines are just some of the medical devices that continue to improve at a rapid pace.

One of the newer developments in surgical technology is a 3D high-definition surgical visualization device from TrueVision Systems (Santa Barbara, CA). In ophthalmic procedures, the 3D high-definition system converts the optical image from the surgical microscope to a digital 3D high-definition image projected onto a specialized "heads-up" viewing screen. In addition to the technology's uses in the OR, the system has the potential for use in the education of fellow surgeons and telemedicine.

There are many benefits to having a 3D viewing system in the OR. First, the surgeon is no longer tethered to the eyepieces during a procedure—freedom allowing for physical flexibility, healthier ergonomics, and greater communication with the rest of the OR team. Second, anyone in the OR can view surgery in 3D; the signal can even be transmitted to allow individuals outside the OR to view the image live or by 3D video feed. Third, the depth of field of the 3D image is superior to what we can see over the microscopic optical field (Figure 1).

THE SYSTEM'S COMPONENTS

The TrueVision system consists of three components: an image capture module; an image processing unit; and a dual projection system. The image capture module is essentially a 3D video camera that attaches to most standard surgical microscopes. It can replace the oculars entirely, or it can work in tandem with the primary oculars with the aid of a binocular beam splitter (Figure 2). When first working with the system, we rec-

Figure 1. Dr. Weinstock performs "heads-up" cataract surgery with the TrueVision system.

Figure 2. The image capture station sits behind the oculars of the microscope.

ommend alternating between operating from the oculars and the screen (it is also a good way to compare the optical and digital images).

The image capture module digitizes the stereo images obtained through the microscope and relays them to the image processing unit (a high-end computer) in real time. The computer enhances and processes the images and then sends one from each ocular view to a dual projection system. Finally, the dual projection system shows the images on a specialized rear projection screen (Figure 3.)

Figure 3. The image processing unit, dual projectors, and screen.

The rear projection screen may be positioned in the OR so that, by slightly tilting his head, the surgeon can adequately view the screen from the side while operating. Three-dimensional polarizing glasses are required to view the screen in 3D high definition. As with any projection system, the room's lights may either be on or off, but the resolution and contrast are better with a slightly darkened OR (Figure 4).

INDICATIONS AND CONSIDERATIONS FOR USE

We have found that the depth of field and magnification with the system are superior to the ocular view with a microscope. It is important to note that the resolution of the TrueVision system is between 80% to 90% of that normally seen through the oculars, so surgeons may prefer to look through the oculars when performing maneuvers for which they need the highest resolution.

For routine cataract surgeries, surface ablation procedures, corneal transplants, phakic IOL procedures, and LASIK, the TrueVision system may be preferable to a traditional ocular view. The technology allows the surgeon to sit up or lean back in a chair and to assume a comfortable position rather than hunch over the eyepieces with his shoulders drooped—the norm when operating though oculars. Ergonomic positioning is especially helpful for longer procedures such as corneal transplants, endothelial transplants, and other surface reconstructions that may require the surgeon to look through the oculars for an extended period of time. The TrueVision system may be similarly helpful for lengthy retinal procedures such as vitrectomies and internal limiting membrane peels.

COMMUNICATION AND EDUCATION

As a communication medium, the TrueVision system enables the OR staff, nurses, residents, fellows, and even members of patients' families to view intraocular surgery on the 3D screen just as the surgeon does. As a result, the scrub technicians and other operating personnel can fully appreciate what is happening during a case and better anticipate the surgeon's needs for additional instrumentation (Figure 5).

The ability to send the 3D high-definition signal to a remote location may be particularly advantageous for teaching institutions. A group of surgeons or students can view the procedure from an auditorium while the surgeon operates in a nearby suite. Real-time viewing allows an exchange of comments, questions, and feed-

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Figure 4. The surgeon must slightly turn his head to see the screen.

Figure 5. The scrub technician and other OR personnel also have a stereoscopic view of the surgical field.

Figure 6. Surgeons watch recorded 3D cases at a Kansas City Ophthalmology Society meeting.

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back between the surgeon and his audience (Figure 6). In addition, the video recording and playback features facilitate teaching and presentation of surgical procedures in 3D.

The TrueVision system also has utility for marketing efforts and lay education. Potential patients can watch surgical procedures from the waiting room or during LASIK or cataract surgery seminars, adding dramatic educational value.

FUTURE APPLICATIONS

TrueVision Systems is developing applications that will enhance the image that is projected on the screen and plans to create software to help ophthalmologists during surgery. In the works is a 3D cursor with which surgeons or their assistants can draw on the screen to guide limbal relaxing incisions, the sizing and formation of the capsulorhexis, and more. Digital applications will make it possible to color code the anterior chamber depth, which will assist surgeons in determining the required depth of instrumentation inside the eye. ■

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