Evaluation of a Stereoscopic Camera-Based Three-Dimensional Viewing Workstation for Ophthalmic Surgery

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PURPOSE: To evaluate the effectiveness of a prototype stereoscopic camera-based viewing system (Digital Microsurgical Workstation, three-dimensional (3D) Vision Systems, Irvine, California, USA) for anterior and posterior segment ophthalmic surgery.

DESIGN: Institutional-based prospective study.

METHODS: Anterior and posterior segment surgeons performed designated standardized tasks on porcine eyes after training on prosthetic plastic eyes.

RESULTS: Both anterior and posterior segment surgeons were able to complete tasks requiring minimal or moderate stereoscopic viewing. The results indicate that the system provides improved ergonomics. Improvements in key viewing performance areas would further enhance the value over a conventional operating microscope.

CONCLUSIONS: The performance of the prototype system is not at par with the planned commercial system. With continued development of this technology, the three-dimensional system may be a novel viewing system in ophthalmic surgery with improved ergonomics with respect to traditional microscopic viewing. (Am J Ophthalmol 2007;143:891–892. © 2007 by Elsevier Inc. All rights reserved.)

CHRONIC NECK AND BACK PROBLEMS ARE PREVALENT IN ophthalmic surgeons and are significant reasons for early retirement, particularly for high-volume surgeons and those who perform prolonged procedures, for example, vitreoretinal surgeons. A major cause of such problems is the neck flexion required to use the operating microscope. The prevalence of neck, upper body, or lower back symptoms in ophthalmologists is reported to be 51.8%.[1] With the advent of a three-dimensional (3D) viewing system, surgeons could gain binocular vision with improved ergonomics.[2] Clinical applications of 3D systems have been used in numerous surgical specialties.[3] The prototype Digital Microsurgical Workstation (3D Vision Systems, Irvine, California, USA) designed for ophthalmology is a positive step in this direction. We report an evaluation of this viewing system in a controlled laboratory environment.

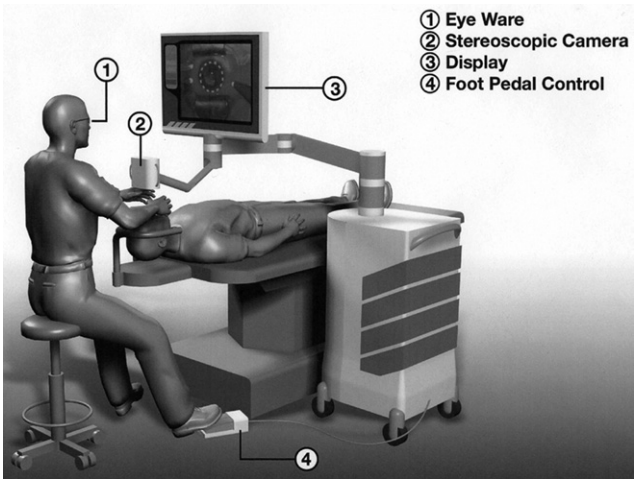

FIGURE 1. The evaluated stereoscopic camera-based viewing workstation for ophthalmic surgery. The components of the system consist of a stereoscopic camera, polarized display screen, polarized glasses for the surgeon and other operating room (OR) personnel to wear, and foot pedal for controls. In this system, a computational platform captures real-time surgery, performs image processing, and displays the indirect stereoscopic view of the operating area via a display screen.

In this system, a computational platform captures real-time surgery, performs image processing, and displays the indirect stereoscopic view of the operating area via a display screen. System components include two cameras, processing circuitry, a polarized screen, and polarized glasses for the surgeon to wear (Figure 1). Ten surgeons who were invited to evaluate the system were initially trained on the equipment using a prosthetic plastic eye. These ten were then divided into two pools of five anterior and five posterior segment surgeons, based on their surgical expertise. For the anterior segment evaluation, surgeons were asked to: (1 insert a 25-gauge needle attached to a 3 ml syringe through the limbus of a porcine eye, (2 insert a cataract knife into the anterior chamber, and (3 perform a capsulorrhexis using forceps. For the posterior segment evaluation, surgeons were asked to: (1 perform a pars plana sclerotomy using an microvitreoretinal (MVR) blade, (2 visualize the retina and vitreous with a 25-gauge endoilluminator, (3 touch and perforate a retinal vessel with a 25-gauge needle, and (4 perform a sheathotomy with a flexible extendable pick (Bausch & Lomb, Rochester, New York, USA). After testing with the 3D system and a conventional operating microscope, all participants filled out a questionnaire regarding their observations. All evaluation scores (−3 to +3) were based relative to an operating microscope (0).

The anterior segment evaluation showed that 100% of the five surgeons were able to enter the anterior chamber with a

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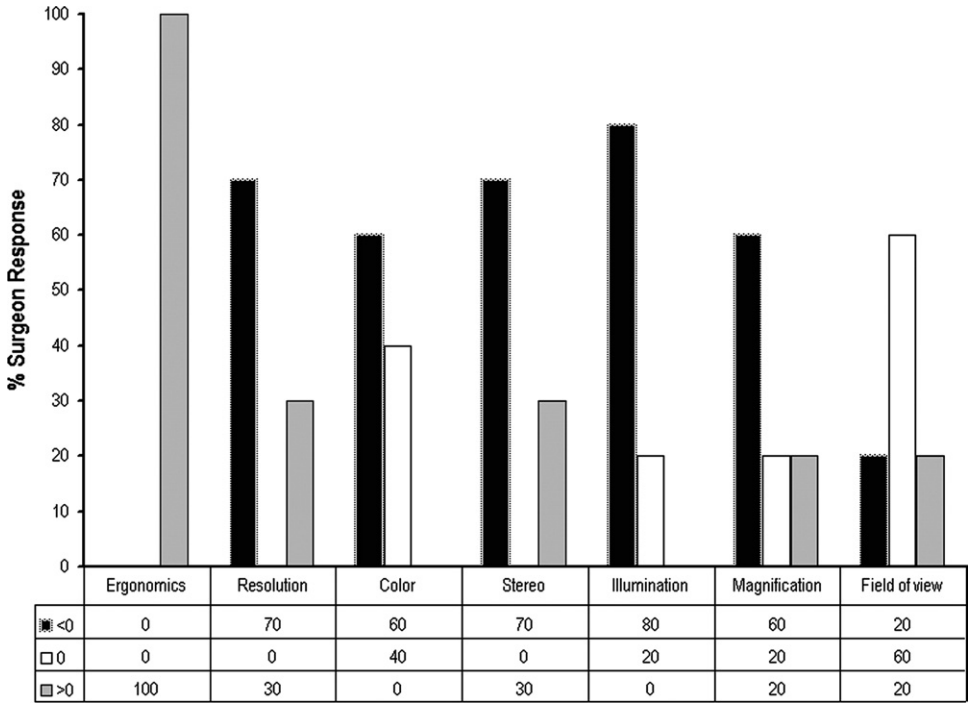

	Ergonomics	Resolution	Color	Stereo	Illumination	Magnification	Field of view
<0	0	70	60	70	80	60	20
0	0	0	40	0	20	20	60
>0	100	30	0	30	0	20	20

FIGURE 2. This graph shows the overall ratings of the surgeons (anterior and posterior segment) in three categories as less than, equal to, or greater than zero, relative to the microscope. All participants rated the ergonomics of the surgical system positively over a standard operating microscope. Twenty percent of the surgeons appraised the three-dimensional (3D) system as superior in magnification and field of view. No surgeon made a positive response for the categories of color or illumination.

25-gauge needle and cataract blade. Capsulorrhexis was successfully performed by 60% of the surgeons. During the posterior segment evaluations, 100% of these five surgeons were able to touch a vessel, 20% were able to perforate a vessel, and 40% were able to perform a sheathotomy.

Figure 2 shows that all 10 participants rated the ergonomics positively. Additionally, 30% of the surgeons gave positive ratings to resolution and stereopsis, 20% to illumination, and 20% to magnification and field of view. Color, stereopsis, and magnification were rated positively by 40% of the anterior segment surgeons. The posterior segment surgeons rated visualization and illumination less favorably, resolution and stereopsis as very limited, and magnification and field of view as equivalent to an operating microscope. All participants perceived the system as a good proof of concept.

Chronic neck and back problems associated with current procedures are a primary concern. All surgeons noted that this system's ergonomics were superior to those of microscopes. The anterior segment surgeons believe that the system could be used in some anterior-based surgeries, recognizing that improvements were still needed. Posterior segment surgeons commented that the system needed additional improvements if it were to be used for vitreoretinal surgery.

In conclusion, in the future, surgical success, operating times, and success rates are all directly related to the surgeon's fine manipulation skills. The majority of current microscopes force the surgeon to operate with a flexed neck that can aggravate neck and back ailments. Although the prototype system reviewed requires further development, a 3D camera system has the potential to improve ergonomics for ophthalmologists.

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