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EW WEEK No. 24

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- Study safety information rule updated
- FDA approves new CL solution
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- Men more likely to have eye injuries
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**REFRACTIVE SURGERY**

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**Tool Time**  
**Eyeing imaging devices**

by Vanessa Caceres EyeWorld Contributing Editor

*Technology provides advantages, but cost and quantitative usefulness are issues*

Although anterior and posterior imaging devices have become easier to use, ophthalmologists say they still have room for future modications. The use of adaptive optics with the devices and the ability to provide better evaluations of the crystalline lens are just two potential future improvements.

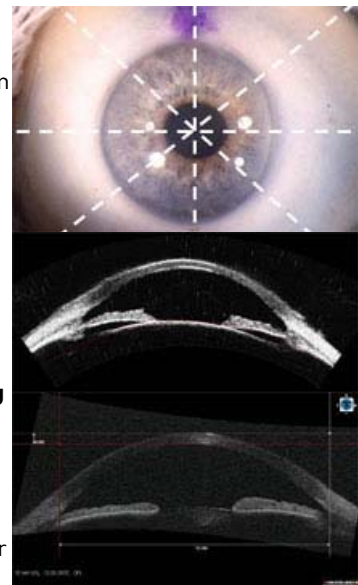
Here's a rundown on how surgeons are using their imaging devices, what advantages and limitations they have with them, and how they'd like to use them going forward.

**Using anterior and posterior imaging**

Ronald R. Krueger, M.D., medical director, refractive surgery, Cole Eye Institute, Cleveland Clinic, Cleveland, uses anterior imaging to determine cornea thickness and depth and posterior imaging such as optical coherence tomography (OCT) to detect retinal problems that could affect anterior segment surgery. "This has become an important component" before completing anterior surgery, he said.

"We use anterior segment imaging in basic research aimed at understanding the mechanisms of myopia development and accommodation and presbyopia as well as to assess the optical and structural outcomes of anterior segment refractive surgery, IOL [intraocular lens] implantation, or contact lens fitting," said Susana Marcos, M.D., Instituto de Óptica Daza de Valdés, Consejo Superior de Investigaciones Científicas, Madrid, Spain.

Surgeons have usually preferred imaging technology depending on the task at hand. For example, Oliver Findl, M.D., consultant ophthalmic surgeon, Moorfields Eye Hospital, London, and associate professor of



**Meridional differences in internal dimensions of the anterior segment in human eyes evaluated with two imaging systems; images were part of a study published in a 2008 issue of the Journal of Cataract and Refractive Surgery; the eyes were scanned at four different meridians: 45 degrees, 90 degrees, 135 degrees, and 180 degrees**  
Source: Liliana Werner, M.D., Ph.D.

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## IOL Calculator

ophthalmology, Medical University of Vienna, Vienna, Austria, uses the Pentacam HD (Oculus, Wetzlar, Germany) to obtain a pachymetric map and measure the cornea's shape, while he uses the Easygraph (Oculus) Placido-based system to screen corneas before cataract surgery. With the latter, he is able to measure the cornea's spherical aberration and select the appropriate IOL. He can also assess corneal astigmatism and axis as a cross check with the IOLMaster (Carl Zeiss Meditec, Dublin, Calif.) results for toric IOLs and incisional surgery.

Dr. Findl uses the RTVue-100 (Optovue, Fremont, Calif.) for corneal OCT, angle measurements, and macular imaging and optic disc evaluation. Liliana Werner, M.D., Ph.D., research associate professor, Department of Ophthalmology & Visual Sciences, John A. Moran Eye Center, University of Utah, Salt Lake City, uses Artemis (ArcScan, Golden, Colo.), a high-frequency ultrasound system to evaluate the fixation, centration, and tilt of IOLs implanted in pseudophakic human donor eyes. "This allows me to evaluate those parameters before the eyes are sectioned for gross evaluation of capsular bag opacification and interaction of the IOL with surrounding tissues," she said.

Dr. Werner also uses the Artemis as well as an anterior segment OCT for research related to the sizing of human eyes.

Dr. Marcos's lab custom-developed imaging devices such as a Purkinje imaging system, an anterior segment OCT device, and optical and geometrical correction distortion algorithms for Scheimpflug imaging. "On the few occasions we use commercial technology, we make sure to validate the technology appropriately as we do in our own devices, using artificial model eyes," she said.

### Pros and cons

Current imaging technology has become easier and faster to use, Dr. Marcos said.

"The in vivo 'biopsy' has added to our understanding of the pathology of the eye, allowing longitudinal observation of subtle changes and the impact of treatment," Dr. Findl said. He also said that imaging can be used as a teaching tool to show patients why they should adhere to glaucoma medication regimens.

Additionally, some of the newer devices provide great resolution, Dr. Werner said. For example, she cites a modified MRI system developed for research on accommodation (MRI Research, Cleveland) that does a particularly stellar job with resolution and details. Dr. Werner used the device in an analysis of Soemmering's ring formation in human eye bank eyes.

At the same time, the data available via imaging is limited because its quantitative use has not been well established, Dr. Marcos said. Devices that some surgeons favor may be perceived as cumbersome by others, Dr. Krueger said. He uses a high-frequency ultrasound method that is not commercially popular because it involves a water immersion. Additionally, the technology can get pricey. "It can be costly, and it's difficult to get adequate payment through use, especially when it's used only by one ophthalmologist in a single practice," Dr. Findl said. "On one hand, I believe some of these technologies are necessary for state-of-the-art practice; on the other hand, there is a financial pressure to use the equipment in as many cases as possible to get adequate reimbursement, which may end up in useless exams being performed. This is an ethical dilemma," Dr. Findl added.

Results from the various imaging systems are routinely studied, and surgeons are cautioned against comparing results that may seem similar but are actually not. For example, a study published in the May issue of the Journal of Cataract and Refractive Surgery found significantly different results for elevation map measurements with the single-Scheimpflug system versus the dual-Scheimpflug system in refractive surgery candidates with healthy eyes. "[This] may lead to misinterpretation of clinical data that could alter clinical decisions if the two imaging systems are considered interchangeable," wrote lead study investigator Ramin Salouti, M.D., Department of Ophthalmology, Poostchi Ophthalmology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran.

### Looking ahead

Anterior and posterior imaging devices of the future could become even more practical, surgeons said. "I envision imaging devices that will be used for general practice, prior to treatments and as evaluation of treatment outcomes," Dr. Marcos said. "In many cases, the techniques should evolve from getting pretty pictures to being truly quantitative." "It will be important that a non-invasive method such as ultrasound

technology be further developed in a way to provide a better evaluation of the crystalline lens," Dr. Werner said. "For example, to be able to measure the pre-operative diameter of the crystalline lens is something that would have relevance for accommodating IOL implantation." Although the modified MRI device that Dr. Werner has used can do this, the technology is not yet easily accessible to ophthalmic surgeons. Along those lines, Dr. Marcos and another investigator published in the May 2009 issue of the Journal of Refractive Surgery on the use of the Pentacam Scheimpflug system to obtain quantitative information on the geometry of the crystalline lens with the use of geometrical and optical distortion correction algorithms. "Applications of corrected Scheimpflug crystalline lens/IOL in vivo imaging include customized eye modeling, studies in quantitative changes of crystalline lens morphology with accommodation, aging, or disease, and assessment of new intraocular implants and surgical approaches for the correction of presbyopia," they wrote.

Dr. Krueger says that imaging methods that are so detailed they enable surgeons to see individual keratocytes and cellular structures are under investigation but not yet commercially available. He is also a fan of adaptive optics, which uses a deformable mirror to cancel wavefront aberrations, giving surgeons a chance to see cones and rods in the retina. Although there are some prototype devices in university settings, there are only anecdotal examples of their performance. That said, adaptive optics could provide insight into retinal diseases, he added. The idea of real-time OCT to guide femtosecond laser sub-Bowman's keratomileusis is also an intriguing possibility, Dr. Krueger said. This approach was successfully used in a small lab study that was published a July 2008 issue of the American Journal of Ophthalmology. Finally, the size of imaging devices and their overall usefulness should be put in context going forward, Dr. Findl believes. "I believe (and hope) that in five to 10 years, we will have a small OCT device hooked onto our slitlamp where we can perform scans in a simple and efficient manner. This would be a great enhancement in our work flow," Dr. Findl said. "However, we do need to watch out that we do not hide behind all our technology and computer systems—patients need counseling and a more complete form of care and treatment."

**Editors' note:** Dr. Krueger has financial interests with Alcon (Fort Worth, Texas). Drs Marcos and Findl did not indicate any financial interests related to their comments. Dr. Werner has no financial interests related to her comments.

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