ASCRS EyeWorld

August 2013

Diagnostic technologies for cataract surgery
Picture-perfect preoperative registration

by Maxine Lipner EyeWorld Senior Contributing Writer

Eyeing methods to align the toric IOL meridian

Toric lenses are increasingly becoming a vital part of many practitioners' armamentariums. New preoperative registration systems seek to align the toric meridian to preoperative landmarks on the eye. From self-directed iris fingerprinting to automated limbal registration systems such as the SensoMotoric Instruments guidance system (Verion, Alcon, Fort Worth, Texas), the TrueVision 3D Surgical system (Santa Barbara, Calif.), iTrace (Tracey Technologies, Houston), and Callisto Eye and Z Align (Carl Zeiss Meditec, Jena, Germany), EyeWorld examined what practitioners can expect from such systems.

Fingerprint shots

From the beginning, when toric lenses were introduced in the U.S., Robert H. Osher, MD, professor of ophthalmology, University of Cincinnati, and medical director emeritus, Cincinnati Eye Institute, recognized that they were eventually going to become the standard of care, but there would be a lot of challenges. Iris fingerprinting was his first attempt to enhance accuracy. "I got frustrated with the fact that ink marks would diffuse 5 degrees, 10 degrees, 15 degrees, and sometimes they would entirely disappear," Dr. Osher said. "It was necessary, in my opinion, to

come up with some alternatives that would be more reliable." Accordingly, he took pictures at the slit lamp when the pupil was dilated during the initial examination. This photograph was overlaid with a software protractor which, he observed, would tell him where every single degree mark was in relation to the unique iris anatomy. "Every landmark I was looking for on the iris corresponded to a specific degree," Dr. Osher said. "I have total confidence that I can find my way around the eye and nail the target meridian," he explained. With the fingerprinting technique, he has had outcomes on the first postoperative day of between 60 and 70% uncorrected 20/20 visual acuity. Systems with software to apply the fingerprinting technique include the Osher Toric Alignment System (OTAS, Haag-Streit, Koeniz, Switzerland) and Micron Imaging Systems (Pegram, Tenn.).

SMI close-up

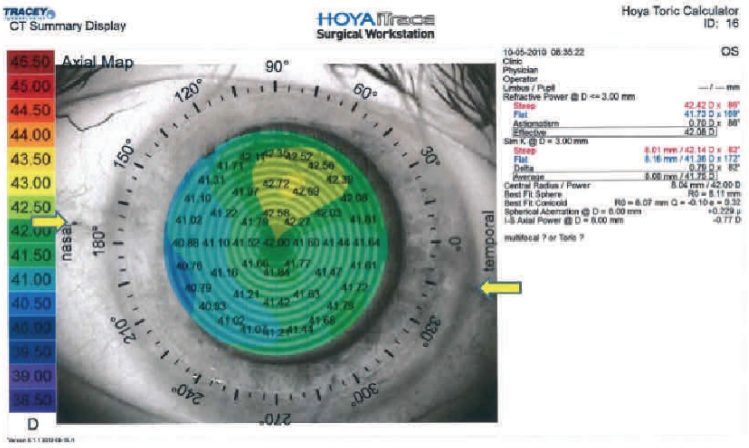
Dr. Osher, who had the first SMI unit in the U.S., has considerable experience with this surgical guidance system, which he explains works by a whole different principle. "There is a preoperative unit that captures an image of the limbus, which is registered on a chip," he said. "In the operating room this sophisticated technology allows the surgeon to select the degree of the target meridian, which then 'guides' the IOL rotation until perfectly aligned." As Sonia Yoo, MD, professor of ophthalmology, Bascom Palmer Eye Institute, Miami, who also has experience with the SMI system, explained it, the system takes a picture of the anterior segment, as well as topography. It is also linked with the operating room microscope, actively offering information while you're operating. "The nice thing about the SMI system is that intraoperatively you have an active axis that moves based on where your lens is," Dr. Yoo said. "You can see where your lens is sitting as you're doing surgery and make adjustments as needed."

Dr. Osher believes that both the SMI unit and his iris fingerprinting technique are better than the traditional method of "guesstimating" with ink marks. However, when marking the target meridian he uses a

new technology dubbed ThermoDot (Beaver-Visitec, Waltham, Mass.) instead of ink. "Rather than an inkblot that may diffuse or even disappear, ThermoDot leaves a pinpoint-sized dot that stays there," he said. He then verifies his fingerprinting results with the SMI unit as well. He also uses the Holos (Clarity Medical Systems, Pleasanton, Calif.) intraoperative wavefront system, which shows in real time where the steepest meridian is located. It also eliminates the necessity of preoperative diagnostics. "I think this approach may prove to be the key to achieving emetropia in the future," he said.

iTrace snapshot

Another system being used for preoperative registration is the iTrace. Dr. Yoo said that while the iTrace is a topography system that is not made for marking, it is a viable application of the device. "The iTrace gives topography that's overlaid on the photograph of the cornea and the limbus," Dr. Yoo said. "You can see some individual patient characteristics on the photograph with the patient's topography overlaid there." For example, she said, there may be some iris crypts or nevi that are particular to the patient's eye, or there may be some limbal vessels that you can see and use as markers. "The nice thing is because you can see them with the topography overlaid on top, you can mark the axis of astigmatism based on these anatomic landmarks," Dr. Yoo said. As Kevin L. Waltz, MD, partner, Eye Surgeons of Indiana, Indianapolis, explained it, the Zaldivar Caliper system on iTrace shows the practitioner either a black and white or color image of the eye and then superimposes the topography on top of that. "It puts marks on the same image so you have reference marks on the sclera or the iris to your IOL orientation," he



iTrace shows digital topography overlay on the pupil. The yellow arrows here show manual ink marks made freehand attempting to mark 0 and 180 degrees. The marks are 15 degrees off axis temporally and 5 degrees off axis nasally.

Source: Sonia Yoo, MD

said. It will also take into account surgically induced astigmatism on the screen. "It will show you where your astigmatism started and with your surgically induced astigmatism where it will end up," he said.

There's a second system that can be used with the iTrace, called the Osher Marking System, Dr. Waltz said. "This uses a high-definition color image and has a different set of marking functions," he said. "It's the same idea, where you can mark the axis preoperatively according to reference marks on the eye." While the Zaldivar system is on all of the iTraces that are currently available, the Osher system is only on the more recent ones but can be added on to the older models as a software upgrade, he explained.

Dr. Yoo views the iTrace system as far more accurate than traditional ink marking methods. "For the surgeons who feel, 'I'm getting good results, I'm accurate with doing it freehand,' if you have the device you can confirm that you are indeed accurate," she said. "What we noticed is that

Callisto system sketch

Another markerless system, the Callisto Eye and Z Align, uses a slightly adapted IOLMaster (Carl Zeiss Meditec), according to Oliver Findl, MD, Department of Ophthalmology, Hanusch Hospital, Vienna. "It's a red-free photograph that shows very nicely the vessels of the conjunctiva and those at the limbus," Dr. Findl said. "This photograph is then imported in the computer, which is connected to the microscope and the laser system in the operating theater." With this system the eye is also tracked. "This means that if I lose the eye during surgery, the alignment is going to track with the eye movement," Dr. Findl said. This helps him to fine-tune the lens positioning at the very end of surgery. When Dr. Findl conducted a trial comparing the system to the conventional marking approach in which a fine mark was placed at the limbus, he found that the results were similar. However, he views the workflow as much nicer with the Callisto, pointing out that when performing thousands of cataract procedures it's possible to forget to mark quite a few patients. "In those cases it's nice to have a markerless system because it doesn't fail," he said.

TrueVision candid

Another system available in this preoperative registration sector is the TrueVision system. Preoperatively this uses the unique i-Optics Cassini corneal LED topographer to obtain keratometry, white-to-white and other data along with an eye image for registration, said Mark Packer, MD, clinical associate professor of ophthalmology, Casey Eye Institute, Oregon Health & Science University, Portland, Ore. With this diagnostic device you're looking at the reflection of lights off the anterior cornea. It uses bright red, yellow and green LEDs. "You have a very bright reflection with a lot of points that overcomes radial symmetry issues with traditional Placido topography," he said.

This digital eye image plus the topographic data is routed to the TrueVision 3D system in the operating room for registration with the actual live view using eye features. There a dynamic guidance algorithm incorporates individual surgeon surgically induced astigmatism and cyclotorsion to optimize incision location and toric IOL alignment to the lowest predicted residual astigmatism, Dr. Packer explained. Currently, the topographic portion obtained here involves only the anterior cornea, but Dr. Packer noted that they are working on capturing the posterior cornea as well.

He views the system as much more precise than working with a blob of ink, which may be 5 to 10 degrees wide. "This is a thin line that runs right across the image of the eye, so lining the toric lens up is very precise," he said.

Dr. Packer uses this registration system in conjunction with the ORA

AT A GLANCE

- With iris fingerprinting, a software protractor is overlaid on a photograph, allowing practitioners to see where every degree mark in relation to an iris landmark is located and ultimately nail the target meridian.
- The SMI system memorizes the anatomy prior to surgery and then is able to automatically identify the target meridian. Intraoperatively it offers precise guidance during toric lens rotation.
- With the iTrace system, a photograph of the cornea and limbus is overlaid with topography. Based on anatomic landmarks, physicians can mark the axis of astigmatism.
- The Callisto Eye and Z Align gives a red-free photograph showing the vessels of the conjunctiva and limbus, which are imported to a computer connected to the microscope and laser system to help fine-tune lens positioning.
- The TrueVision system optimizes wound placement and automatically registers the preoperative topography data and an eye image to the live 3D view of the eye, enabling digital guidance overlays with eyetracking for toric IOL alignment.
- Intraoperative aberrometry can offer a real-time refractive solution that may eliminate the necessity of preoperative diagnostics.

(WaveTec Vision, Aliso Viejo, Calif.), which he said takes into account the posterior cornea. "TrueVision adds a lot for the astigmatism because the one thing that ORA does not allow is registration," Dr. Packer said. Between the two systems Dr. Packer has found that he has an enhancement rate of about 3%, compared with a pretty consistent 8% for sphere and cylinder over the years without these technologies. Going forward, Dr. Packer thinks that it's going to be important to find ways to merge these technologies and see where they fit in with femtosecond cataract surgery. Likewise, Dr. Yoo believes that with the merging of technologies such as intraoperative autorefraction and eye tracking, the ability to perfectly place toric lenses will improve as well. "I think that we'll continue to see this technology evolve in the near future," Dr. Yoo said.

***Editors' note**: Dr. Findl has financial interests with Carl Zeiss Meditec. Dr. Osher has financial interests with Alcon, Clarity Medical Systems, Beaver-Visitec, and Haag-Streit. Dr. Packer has financial interests with TrueVision 3D Surgical and WaveTec Vision. Dr. Waltz has financial interests with Abbott Medical Optics (Santa Ana, Calif.) and Tracey Technologies. Dr. Yoo has no financial interests related to this article.*

Contact information

Findl: oliver@findl.at
Osher: 800-544-5133, rhosher@cincinnatieye.com
Packer: 541 915 0291, mark@markpackerconsulting.com
Yoo: 305-326-6322, syoo@med.miami.edu
Waltz: 317-845-9488, klwaltz@aol.com