

# Reducing Postkeratoplasty Astigmatism: Finding the Holy Grail With ORange

New technology helps surgeons correct residual refractive error and astigmatism in an era of patients' exceedingly high expectations.

BY NEEL R. DESAI, MD

Exciting new technology has the potential to improve surgical outcomes for patients undergoing penetrating keratoplasty (PKP). More than 40,000 corneal transplants are performed each year in the United States, with an increasing proportion represented by lamellar corneal transplants (endothelial or deep anterior lamellar). My patients and I have enjoyed the benefits of these technical advances in corneal transplantation, which include more predictable visual outcomes, faster visual recovery, greater safety from smaller wounds, and in particular, less postoperative irregular astigmatism. As long as there are clinical circumstances requiring traditional PKP, however, surgeons and patients will struggle with high postoperative astigmatism. A successful PKP procedure requires both an optically clear graft *and* functional vision for the patient. ORange Intraoperative Wavefront Aberrometer (WaveTec Vision, Aliso Viejo, CA) may help.

## UNDERSTANDING POST-PKP ASTIGMATISM

A multitude of factors contribute to postkeratoplasty astigmatism, including differences in graft-host parameters, radial tissue distribution, radial suture alignment, and variability in suture tension. Surgeons have employed numerous techniques to reduce induced astigmatism, such as marking devices, specialized trephines, torque and anti-torque running suturing techniques, and intraoperative keratometry. Femtosecond laser-guided keratoplasty may one day play a role as well.

Historically, the use of intraoperative keratometry relied on the interpretation of Placido disc images to refine and adjust the placement and tension of sutures. I have found that my "poor-man's" Placido disc—the loop-end of a large safety pin—provides a useful, albeit gross, assessment of keratometric astigmatism at the end of a case (Figure 1). Newer technology, like ORange, may provide surgeons

with an advanced tool to help fully realize a successful corneal transplant.

My colleagues and I have been successfully using ORange technology for a host of applications during refractive cataract surgery. With the aberrometer's real-time data, we have achieved positive results with the accurate placement of toric IOLs, refinement of astigmatic keratectomies, and intraoperative calculation of lens power in postrefractive surgery patients. I have recently begun to experiment with ORange during PKP in hopes that it may similarly improve outcomes.

## THE SCIENCE BEHIND ORANGE

ORange attaches directly to the surgical microscope for intraoperative use. A processor analyzes the data and provides images on a touch screen workstation, thus giving surgeons real-time information regarding sphere, cylinder, and axis.

The device uses Talbot-Moiré-based interferometry to



Figure 1. A sterile looped safety pin can be used as a simple Placido disc keratometer.

analyze the wavefront reflected out of the eye by relaying it through an optical system and directing it through a pair of gratings that are set at a specific distance from, and offset angle to, each other.<sup>1</sup> The reflected light is diffracted as it passes through the gratings and creates a fringed pattern. This pattern is captured by a camera and then processed using WaveTec Vision's proprietary algorithms to provide refractive data.



**Figure 2.** Screen images provided by ORange intraoperative aberrometer. The instrument detects significant astigmatism prior to suture adjustment (A). Intraoperative wavefront-guided suture adjustment reduced astigmatism considerably (B).

### USING ORANGE FOR PKP

Keratometry provides only limited corneal data, and the benefits of modifications in surgical technique may only be measured postoperatively. In contrast, ORange can theoretically provide real-time intraoperative data on the patient's entire optical wavefront. Surgeons can now fully take into account the lens status and tilt, as well as lenticular astigmatism, when adjusting running sutures intraoperatively.

### MY ROUTINE PKP

For routine primary PKP, I prefer a 16-bite antitorque running suture of 10–0 nylon, after the placement of eight interrupted cardinal sutures. After tying a slipknot in the running suture, I remove the cardinal sutures and progressively tighten each bite of the running suture from the 6- to the 12-o'clock position to produce a nicely apposed graft-host junction and regular with-the-rule or oblique astigmatism. I then tie the knot securely and use my poor-man's Placido disc to appropriately distribute the tension on the running suture. As demonstrated in the images from a recent case (Figure 2), I use ORange to capture complete wavefront data that will guide my adjustments. Capturing wavefront images through an edematous graft with an irregular epithelium requires some effort and a measure of patience, but the resulting refractive data allow incremental adjustment of sutures with real-time feedback. Instead of leaving this keratoconic eye with 7.00 D irregular astigmatism, I could be confident of a more manageable result of 2.50 D or less. Later refractive cataract surgery can target emmetropia.

### REDUCED ENHANCEMENTS

Use of ORange is already reducing the number of LASIK enhancements required after refractive cataract surgery. One retrospective study analyzed the impact of wavefront-guided limbal relaxing incisions at the time of surgery on

the rate of future postoperative laser enhancements.<sup>2</sup> In the first group of eyes ( $n = 37$ ) in which ORange was not used, six (16%) went on to have a LASIK enhancement. In a second group of patients ( $n = 30$  eyes) with similar refractive characteristics in which ORange was used, only one patient (3%) went on to have a LASIK enhancement. Interestingly, among the 30 eyes in which ORange was used, eight (27%) eyes received unplanned limbal relaxing incisions during the procedure based on ORange's findings, possibly reflecting the benefit of having refractive data available for intraoperative decision making in real time.

Prior to the introduction of ORange, wavefront data could only be used pre- and postsurgically, leaving the surgeon unaided during the actual procedure and anxiously awaiting stable refractive data after the procedure. Patients' exceedingly high expectations for advanced cataract surgery and premium IOL technology make the intraoperative determination and correction of residual refractive error and astigmatism particularly important.

For surgeons who are now using ORange intraoperative wavefront aberrometer, it has quickly integrated itself into our routine practice and become an invaluable tool in providing patients the best outcome possible after cataract surgery. It is clear that such technology may affect other outcomes, such as the reduction of postkeratoplasty astigmatism, as we strive to give our patients the best vision and the best quality of life possible. ■

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1. WaveTec Company. <http://www.wavetecvision.com/company/orange-technology>. Accessed February 18, 2010.

2. Madavi S. Using real-time feedback during cataract surgery to improve refractive outcomes. <http://www.wavetecvision.com/sites/default/files/Madavi%20economic%20paper.pdf>. Accessed February 18, 2010.