Treating Astigmatism With the Femtosecond Laser

Manually creating limbal relaxing incisions is challenging for surgeons and can be fraught with errors. Enter the femtosecond laser.

BY ERIC D. DONNENFELD, MD, AND ALLON BARSAM, MD, MRCOPHTH

The correction of preexisting corneal astigmatism and the prevention of surgically induced astigmatism are essential to successful surgical outcomes, a high quality of postoperative vision, and patients' satisfaction. Residual astigmatism after cataract surgery of 0.50 D or even less may result in glare, symptomatic blur, ghosting, and halos.[1] As a result, ophthalmologists are placing a greater emphasis on treating corneal astigmatism at the time of cataract surgery with limbal relaxing incisions (LRIs). A recent study of 4,540 eyes (2,415 patients) showed that corneal astigmatism is present in the majority of patients undergoing cataract surgery, with at least 1.50 D measured in 22.2% of eyes.[2] Approximately 38% of eyes undergoing cataract surgery have at least 1.00 D of preexisting corneal astigmatism, and 72% of patients have 0.50 D or more.[3]

Unfortunately, most cataract surgeons are uncomfortable manually creating astigmatic incisions. In a survey of 233 surgeons, only 73 routinely performed LRIs.[4] A major sticking point is that novice surgeons have numerous opportunities to err during the manual LRI procedure, and the combination of these mistakes can result in suboptimal visual acuity. Potential problems associated with LRIs include overcorrection, undercorrection, infection, perforation of the cornea, decreased corneal sensation, induced irregular astigmatism, and ocular discomfort. A perforated cornea may self-seal or may require a suture. The proper manual creation of an LRI is as much an art as a science.

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MANUAL VERSUS LASER INCISIONS

Recent technological developments have shifted ophthalmologists' attention from manually created LRIs and astigmatic keratotomy procedures to femtosecond laser-guided procedures. Femtosecond lasers offer superior incisional accuracy and reproducibility coupled with minimal effects on collateral tissues, achieving levels of safety and reproducibility exceeding those of mechanical techniques.[5,6] A major clinical application of the femtosecond laser is for creating arcuate incisions that have a precise and accurate length, depth, angular position, and optical zone. Optical coherence tomography-controlled corneal pachymetry is performed directly in the area of the intended incisions and then programmed into

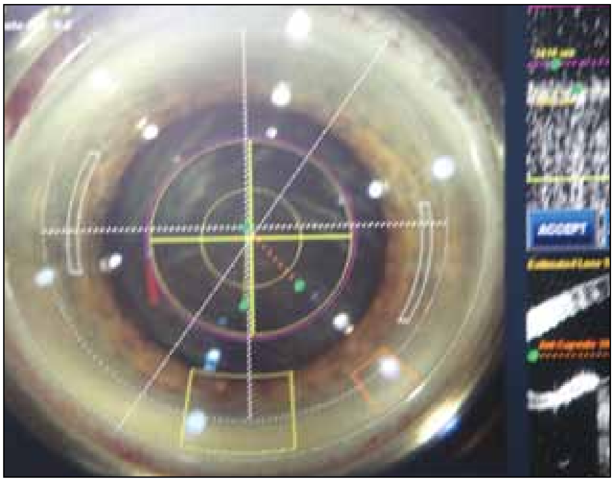

Figure 1. Overlay of the femtosecond arcuate, phaco, and sideport incisions.

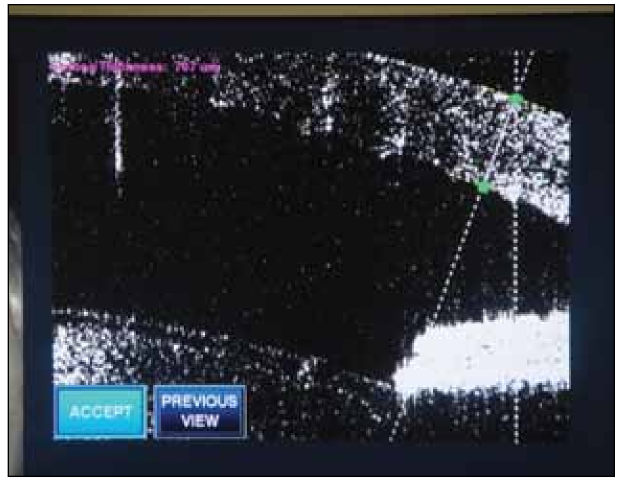

Figure 2. Optical coherence tomography of the cornea in the area of the arcuate incision confirms its depth.

the laser, which allows for extreme precision. In a recent study, the depth and location of the incisions were consistent with the surgical plan, causing the investigators to conclude that the femtosecond laser creates uniform corneal incisions more precisely and predictably than manual techniques.[7,8]

Femtosecond lasers can be programmed to create an ideally shaped incision with three planes for phacoemulsification. Their enhanced sealing and healing are associated with a reproducibility in the induction of astigmatism that cannot be achieved with manual keratomes. In a study of the initial results with the LenSx Laser (Alcon Laboratories, Inc.) using 9-mm arcuate incisions and a 33% reduction of the Donnenfeld nomogram, the investigator achieved a 70% decrease in astigmatism.[9] Incisions created with a femtosecond laser can also be placed intrastromally (obviously impossible with a manual LRI) in the sub-Bowman layer of the cornea, which improves healing by not damaging the corneal epithelium. Further clinical investigation and nomogram development are underway to optimize this method.

RESULTS AND REFINEMENT

After laser treatment, the patient is brought to the operating microscope, where the authors open the incisions with a Sinskey hook. The incisions are symmetric and standardized at 9 mm from the visual axis (Figure 1). Optical coherence tomography confirms their postoperative depth (Figure 2). A major advantage of arcuate incisions created with a laser is that the refractive incisions do not exert a significant effect until they are opened, which permits modification intraoperatively and/or postoperatively.

To further refine their results, the authors are performing intraoperative aberrometry (ORA; WaveTec Vision) in the OR. The authors remove the cataract, place the IOL, and open one of the laser incisions with a Sinskey hook. The IOP is then raised to approximately 25 mm Hg. Next, the authors perform intraoperative aberrometry, which provides an accurate reading of the existing astigmatism. The second laser incision may then be opened partially or completely, based on the intraoperative aberrometry reading (which can be taken again). Surgeons who do not have access to the ORA can examine patients with

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topography and refraction on the day after surgery. If needed, the remainder of the incision can be easily opened in the office to increase its effect and adjust the patient's residual astigmatic refractive error.

CONCLUSION

The creation of arcuate incisions using a femtosecond laser is a novel technique that gives surgeons the precision of image-guided technology. Refractive incisions are now controlled with a computer and do not rely on surgeons' skill or experience. The use of the femtosecond laser system should make the creation of astigmatic incisions faster, safer, easier, customizable, adjustable, and fully repeatable. Removing the inconsistencies of this procedure will improve surgeons' understanding of astigmatic incisions as well as their accuracy, thus improving refractive results and patients' satisfaction. Still required are the development of new nomograms and more clinical experience. ■

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1. Nichamin LD. Nomogram for limbal relaxing incisions. *J Cataract Refract Surg*. 2006;32(9):1048.
2. Ferrer-Blasco T, Montés-Micó R, Peixoto-de-Matos SC, et al. Prevalence of corneal astigmatism before cataract surgery. *J Cataract Refract Surg*. 2009;35(1):70-75.
3. Hill W. Expected effects of surgically induced astigmatism on AcrySof Toric intraocular lens results. *J Cataract Refract Surg*. 2008;34(3):364-367.
4. Duffey RJ, Leaming D. US trends in refractive surgery: 2008 ISRS/AAO survey. Presented at: The International Society of Refractive Surgery & American Academy of Ophthalmology; November 8, 2008; Atlanta, GA.
5. Masket S, Sarayba M, Ignacio T, Fram N. Femtosecond laser-assisted cataract incisions: architectural stability and reproducibility. *J Cataract Refract Surg*. 2010;36(6):1048-1049.
6. Nichamin L. Femtosecond laser technology applied to lens-based surgery. June 22, 2010. Medscape Ophthalmology. http://www.medscape.com/viewarticle/723864. Accessed February 13, 2012.
7. Nagy Z, Takacs A, Filkom T, Sarayba M. Initial clinical evaluation of an intraocular femtosecond laser in cataract surgery. *J Refract Surg*. 2009;25(12):1053-1060.
8. Abbey A, Ide T, Kymionis GD, Yoo SH. Femtosecond laser-assisted astigmatic keratotomy in naturally occurring high astigmatism. *Br J Ophthalmol*. 2009;93(12):1566-1569.
9. Slade SG. Femtosecond laser arcuate incision astigmatism correction in cataract surgery. Presented at: 2011 Cornea Day/ASCRS Symposium on Cataract, IOL and Refractive Surgery; March 25, 2011; San Diego, CA.