Successfully Reducing Astigmatism With LENSAR-Assisted Arcuate Incisions

The reduction of surgical variables helps reduce the risk of postsurgical refractive surprise.

Based on videos produced on behalf of LENSAR, Inc., following is the first in a series of articles highlighting features of the LENSAR Laser System. The video may be found at Eyetube.net or by following the QR code found here. This installment describes why Jonathan Solomon, MD, of Solomon Eye Physicians and Surgeons, believes the LENSAR Laser System has been integral in correcting surgically induced and residual astigmatism at the time of cataract surgery.

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Using the LENSAR Laser System (LENSAR, Inc.), Jonathan Solomon, MD, of Solomon Eye Associates, is able to reduce surgically-induced and preexisting astigmatism in patients who would otherwise not have the benefit of a near-plano spherical outcome. Further, his results have been reproducible, demonstrating the reliability of both the LENSAR Laser System and his nomogram as viable tools for reducing astigmatism and improving refractive outcomes in premium cataract patients.

REDUCTION OF RESIDUAL AND SURGICALLY-INDUCED ASTIGMATISM IN A PILOT STUDY

In the setting of a small pilot study, Dr. Solomon used the LENSAR femtosecond laser to treat 20 eyes of 14 patients with an average preoperative topographic cylinder of 1.09 D ±0.25 D. He treated these eyes with a trilamellar clear corneal incision using a near-full thickness, opposite, on-axis incision as a means to alleviate their astigmatism. He made arcuate incisions using the LENSAR Laser System with a radius of 4.5 mm and a width of 2.87 mm ±0.14 mm. Prior to titrating the incisional dissection, Dr. Solomon and his staff performed pre- and intraoperative examinations, including aphakic intraoperative aberrometry using the ORA System with VerifEye (WaveTec Vision).

Using this combination of a clear corneal incision with an intrastromal arcuate incision, Dr. Solomon was able to reduce the residual refractive error in the studied patients to less than 0.50 D. The average postoperative cylindrical refraction for the treated eyes was 0.31 D ±0.29 D ($P < .01$). In addition, Dr. Solomon found that his surgically-induced astigmatism dropped from about 0.33 D to less than 0.25 D with the same 2.87 mm ±0.14 mm incisions. This improvement showed that carefully calculated arcuate incisions using the LENSAR Laser System relieved preoperative astigmatism and reduced unwanted surgically-induced refractive error, yielding better overall visual outcomes for the patients in the study.

REDUCING ASTIGMATISM STARTS WITH RELIABLE CORNEAL IMAGING

To successfully reduce astigmatism using LENSAR-assisted arcuate incisions, Dr. Solomon relies on the LENSAR Laser System's advanced technology, beginning with imaging. LENSAR's imaging system and Augmented Reality technology allows Dr. Solomon to obtain a clear, reliable image of the entire anterior segment, including a detailed view of the cornea. The on-board Scheimpflug imaging for intraoperative use provides Dr. Solomon with an extremely precise understanding of the corneal architecture throughout the cornea, including the exact site of the incision.

Other laser imaging systems display images at the 90° and 180° meridians only and rely on image stitching to create a display. The LENSAR Laser System scans the entire eye, including the corneal anatomy at the site of the incisions, and provides a complete image of the anterior segment, from the anterior cornea to the posterior lens capsule. Equipped with optical ray-tracing, the LENSAR Laser also provides an anatomically accurate three-dimensional rendering of the anterior segment, which is used for treatment planning prior to surgery.

To achieve the quality of imaging that the LENSAR Laser provides, the LENSAR Augmented Reality camera utilizes the Scheimpflug Principle to take 16 images, both on- and off-axis, to ensure high resolution and complete aerial views of the optical anatomy with minimal image stitching.

For Dr. Solomon, it is the high quality and accuracy of the corneal image, in combination with LENSAR's laser precision and Intelligent Incisions software, that helps him achieve astigmatism reduction and further refine his outcomes. According to Dr. Solomon, "When you start with good-quality

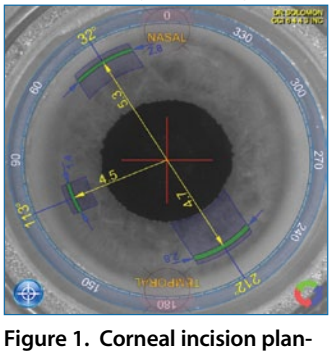

Figure 1. Corneal incision planning provided by the LENSAR Laser System.

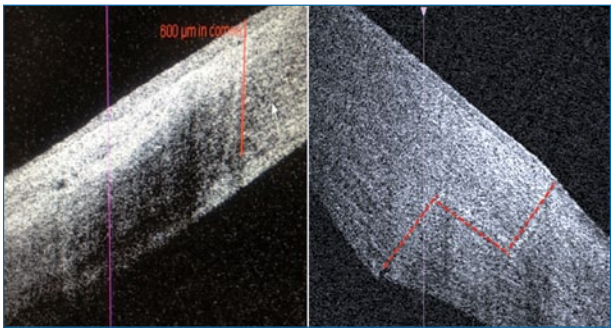

Figure 2. LENSAR intrastromal arcuate incisions and architecture.

data in, you are going to get good-quality outcomes at the conclusion of the case."

PRECISION OF LENSAR LASER PULSES CONTRIBUTES TO ASTIGMATISM REDUCTION

The precision of the femtosecond laser is another critical element that Dr. Solomon relies upon to help his astigmatic cataract patients achieve such favorable outcomes. Several aspects of the LENSAR Laser System were designed specifically to ensure that the laser delivers pulses both reliably and precisely, so surgeons can not only have more confidence, but also so patients may have a safe experience.

To preserve corneal integrity and eliminate corneal artifacts such as folds and striae, the LENSAR Laser employs a non-applanating, fluid-filled patient interface. When coupled with LENSAR's detailed imaging, surgeons can feel confident that the laser pulses will be placed where intended. Additionally, LENSAR's imaging system is in the same axis as the laser, so what is being viewed is where the laser will be firing; there is no complexity in recalibrating the laser based on off-axis imaging. In Dr. Solomon's study of reducing astigmatism using intrastromal arcuate incisions, this type of laser precision was paramount in achieving his desired outcomes.

LENSAR'S INTELLIGENT INCISIONS HELPS GUIDE PRECISE CORNEAL INCISIONS

To ensure the accuracy of laser pulses in the cornea, the LENSAR Laser uses a proprietary feature called Intelligent Incisions. This feature provides imaging of the cornea just prior to the incision-making process to compensate for any movement, regardless of how minute, that might have occurred since the start of the procedure when the initial scans were captured. This software compensates for corneal tilt and curvature and identifies and adjusts the incision based on any microscopic corneal movement that may occur. An image is captured as each incision is being made in each plane, so that the corneal incisions are placed where intended. This precision helps contribute to incisions that are easy to open at the start of the procedure and that consistently seal at the end of the procedure (Figures 1 and 2).

A With-the-Rule Paired	4.5 mm Radius/75 um Residual Bed	# eyes
0.75 < 1.25 D	30 degrees	35
1.25 < 1.75 D	50 degrees	21
1.75 < 2.25 D	70 degrees	8
Against-the-Rule Opposite Single	**4.5 mm Radius/75 um Residual Bed**	**# eyes**
0.75 < 1.25 D	45 degrees	22
1.25 < 1.75 D (p)	60 degrees	13
1.75 < 2.25 D (p)	90 degrees	4

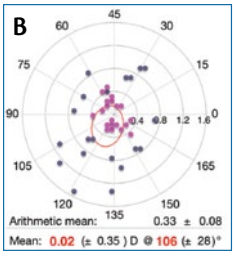

Figure 3. Using an updated nomogram (A) based on one designed by Louis "Skip" Nichamin, MD, Dr. Solomon is able to produce a linear, reproducible reduction of astigmatism across his patients (B).

The sophistication of Intelligent Incisions and the LENSAR Laser System's ability to make full- and partial-thickness, single-plane, and multi-plane cuts in the cornea for accurate paracentesis, precise entrance incisions, and proprietary arcuate incisions are what ultimately made Dr. Solomon's study results possible.

LENSAR LASER-ASSISTED NOMOGRAM FOR ASTIGMATISM REDUCTION

Dr. Solomon is currently working with LENSAR, Inc., to develop a laser-assisted nomogram that can be followed to reduce astigmatism, as demonstrated in his study. Based off of an earlier nomogram developed by Louis "Skip" Nichamin, MD, Dr. Solomon's nomogram v2.0 achieves a similar type of reproducible outcome by relying on three elements: the incision's arc, radius, and depth (Figure 3).

FEMTOSECOND LASERS AND THE FUTURE OF ASTIGMATISM CORRECTION

In this day and age, it is widely accepted and agreed that laser-assisted cataract surgery allows for a higher level of precision. It can also be said that refractive cataract surgeons need multiple arrows in their quivers to be able to treat the gamut of cataract cases, from the most basic to the most complex. Dr. Solomon believes that the LENSAR Laser System femtosecond cataract laser allows surgeons to treat a wide range of patients—many of whom may otherwise be less-than-optimal candidates due to their astigmatism—with reproducible and desirable visual outcomes. ■

Jonathan Solomon, MD, is surgical/refractive director of Solomon Eye Physicians and Surgeons in Greenbelt and Bowie, Maryland, and McLean, Virginia. He is a consultant to and speaker for WaveTec Vision. Dr. Solomon may be reached at jdsolomon@hotmail.com.