

# Corneal Relaxing Incisions

Advanced pearls.

BY LOUIS “SKIP” D. NICHAMIN, MD

The need to manage preexisting astigmatism has become a requisite of modern phaco surgery. Ophthalmologists' experience with keratorefractive surgery has proven that astigmatism of as little as 0.75D may leave a patient symptomatic with visual blur, ghosting, and halos. To fully embrace the notion of refractive cataract surgery, the dedicated surgeon must aspire to a level of accuracy equated with corneal-based refractive surgery. The most popular approach to achieve this goal is the use of corneal incisions—specifically, limbal relaxing incisions (LRIs).

## HISTORY

The modern era of cataract and astigmatic surgery began in the mid-1980s, when Robert Osher, MD, and other pioneering surgeons first suggested that astigmatic keratotomy might be combined with cataract and implant surgery.<sup>1,2</sup> In time, the benefit of moving these incisions to a more peripheral limbal location became evident.<sup>3-5</sup>

LRIs hold several advantages compared with astigmatic keratotomy incisions placed at a more central optical zone. They include a lesser tendency to cause a shift in the resultant axis of cylinder and a lower likelihood of inducing irregular astigmatism. LRIs are also easier to create and are more forgiving overall. Another advantage involves the coupling ratio, which describes the amount of flattening that occurs in the incised meridian relative to the amount of steepening that results 90° away. Because paired LRIs (when kept at or under 90° of arc length) exhibit a consistent 1:1 ratio, they elicit little change in spheroequivalence and obviate the need to change the IOL's power.

## MEASUREMENTS

Perhaps the most challenging aspect of astigmatic surgery involves determining the quantity and exact location of the cylinder to be corrected. Unfortunately, preoperative meas-

urements—keratometry, refraction, and corneal topography—do not always correlate. Lenticular astigmatism may account for some of this disparity, particularly in cases where there is a wide variance between the refraction and corneal measurements. Some discrepancies, however, are likely due to the inherent shortcomings of the traditional measurements of astigmatism. Standard keratometry, for example, measures only two points in each meridian at a single optical zone of approximately 3mm.

When faced with confounding measurements, one solution is to compromise and average the disparate readings. For example, if the refraction shows 2.00D of astigmatism and keratometry reveals only 1.00D, it would be reasonable to correct for 1.50D. Alternatively, if the preoperative calculations vary widely, one may defer placing the relaxing incisions until the patient's refraction stabilizes after cataract surgery. The LRIs may be safely performed in the office in an appropriate treatment-room setting.

Corneal topography can also be helpful when the refraction and keratometry do not agree. It is also useful for detecting subtle corneal pathology such as forme fruste

## POTENTIAL PROBLEMS

- Infection
- Weakening of the globe
- Perforation
- Decreased corneal sensation
- Induced irregular astigmatism
- Misalignment/axis shift
- Wound gape and discomfort
- Operating upon the wrong (opposite) axis!

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## RELAXING INCISIONS WITH THE TERRY-SCHANZLIN ASTIGMATOME

By Wesley K. Herman, MD

The Terry-Schanzlin Astigmatome (OASIS Medical, Inc., Glendora, CA) is a precise, standardized system for creating corneal relaxing incisions to treat astigmatism. The unit consists of a suction fixation device and a series of templates with degree guides for 30° to 90° single or paired arcuate incisions. Optical zones of 8 or 10mm are available at depths of 600 to 700µm. The disposable knife assembly is used on one patient (one or two eyes). I use the Terry-Schanzlin Astigmatome in the following manner when performing corneal relaxing incisions.

#### MY TECHNIQUE

After anesthetizing the cornea with topical tetracaine, I irrigate the ocular surface with saline and place a drop of Zymar (Allergan, Inc., Irvine, CA) or Vigamox (Alcon Laboratories, Inc., Fort Worth, TX). I confirm and mark the astigmatic axis based on the topography and refraction and then validate it with intraoperative corneal topography.

Before making the corneal relaxing incisions, I test the knife and appropriate template to ensure their smooth operation. My assistant holds the open knife until I need it. I then irrigate the ocular surface with saline and place the Terry-Schanzlin Astigmatome's vacuum apparatus on the cornea. Most patients tolerate the use of a curved-aperture LASIK speculum, but the suction device may be used without a speculum in eyes with small lid apertures. I only employ the large suction syringe, because I have found that the smaller one can break suction too easily.

After confirming suction, I apply several drops of Celluvisc (Allergan, Inc.) or Blink (Advanced Medical Optics, Inc., Santa Ana, CA) to the suction well. I gently drop the knife into the suction apparatus and orient it to cut clockwise only. I incise 30° per diopter and prefer to use a larger template than necessary so that I can make cuts to the full extent of my degree nomogram.

Upon completion of the incisions, I withdraw the knife, release the suction, and irrigate the cornea with saline. I administer a drop of Zymar or Vigamox and generally place a bandage contact lens by means of a closed-cell sponge (OASIS Medical, Inc.). I instill an additional antibiotic drop, remove the speculum, and discharge the patient.

I normally see patients at 1 day (when I remove the bandage contact lens) and 3 to 4 weeks postoperatively. Patients treated for 1.00 to 2.00D of astigmatism who have healthy, moist corneas may not require a bandage contact lens. All patients use antibiotic steroid drops (eg, Tobradex [Alcon Laboratories, Inc.]) q.i.d. for 5 to 6 days postoperatively.

Viscolubrication is beneficial intraoperatively as a means for helping to avoid epithelial defects. Patients use artificial tears pre- and postoperatively.

#### TIPS

For symmetrically meridional astigmatism, I use a double 8-mm optical zone and a cutting depth of 600µm. I employ the 10-mm optical zone knife in cases of previous keratoplasty or for astigmatism that is greater than 5.00D, for which 8- to 10-mm cuts are appropriate.

In eyes with asymmetric astigmatism, I have achieved excellent results by using a single blade and paying careful attention to topography and intraoperative corneal topography while making double, or occasionally triple, cuts.

In numerous patients with perfectly spherical equivalent myopia and astigmatism, I have performed corneal relaxing incisions in lieu of LASIK or PRK. The results have been outstanding with rapid visual rehabilitation but no violation of the corneal-visual axis.

*Wesley K. Herman, MD, is a corneal, refractive, and refractive cataract surgeon and Founder of Vision Quest in Dallas. He acknowledged no financial interest in the products or companies mentioned herein. Dr. Herman may be reached at (214) 361-1443; wes@hermanplace.com.*

keratoconus, which would likely contraindicate the use of LRIs, or subtle irregular astigmatism such as that caused by epithelial basement membrane dystrophy.

#### NOMOGRAMS

After calculating the amount of astigmatism to correct, one must consult a nomogram<sup>6</sup> to determine the appropriate arc length of the incisions. My nomogram of choice originated with the work of Stephen Hollis, MD, and incorporates concepts (particularly age modifiers) taught by Spencer Thornton, MD.<sup>7</sup> Astigmatism is considered to be with the rule if the steep axis (plus cylinder) is between 45° and 135° (Table 1). Against-the-rule astigmatism falls between 0° to 44° and 136° to 180°. One aligns the patient's

age with the amount of preoperative cylinder to be corrected and finds the suggested arc length that the incisions should subtend.

Cataract surgeons commonly set the blade's depth (typically at 600µm) empirically when performing LRIs. In the setting of refractive lens exchange surgery or when employing presbyopia-correcting IOLs—when ultimate precision is required—I prefer to perform pachymetry and adjust the blade's depth. One may perform pachymetry either preoperatively or at the time of surgery. Readings are taken over the entire arc length of the intended incision, and an adjustable micrometer diamond blade is then set to approximately 90% of the thinnest reading obtained. Refinements to the blade's depth setting as well as nomogram adjustments may

be necessary depending upon individual surgical technique, the instruments used, and the style of the blade.

In eyes that have previously undergone RK, the surgeon should reduce the length of the incisions by approximately 50%. It may be best to avoid relaxing incisions in favor of a toric IOL in eyes that have undergone significant prior keratotomy surgery.

## SURGICAL PEARLS

### When

Generally, one places the relaxing incisions at the outset of surgery in order to minimize epithelial disruption. The one exception is when the phaco incision intersects

or is encompassed within an LRI of greater than 40° of arc. Extending the incision to its full arc length at the start of surgery may produce significant gaping and edema secondary to the intraoperative manipulation of the wound. In this setting, one first makes the phaco incision by creating a shortened LRI, the arc length of which corresponds to the width of the phaco and IOL incision. It is essentially a two-planned, grooved phaco incision with a depth of 600µm (or as determined by pachymetry).

After implanting the IOL but before removing the viscoelastic, while the globe is still firm, the surgeon extends the relaxing incision to its full arc length as dictated by

**TABLE 1. THE "NAPA" NOMOGRAM**

### WITH THE RULE (Steep Axis 45° to 135°)

PREOPERATIVE CYLINDER (Diopters)	Paired Incisions in Degrees of Arc					
	20 to 30 years old	31 to 40 years old	41 to 50 years old	51 to 60 years old	61 to 70 years old	71 to 80 years old
0.75	40	35	35	30	30	
1.00	45	40	40	35	35	30
1.25	55	50	45	40	35	35
1.50	60	55	50	45	40	40
1.75	65	60	55	50	45	45
2.00	70	65	60	55	50	45
2.25	75	70	65	60	55	50
2.50	80	75	70	65	60	55
2.75	85	80	75	70	65	60
3.00	90	90	85	80	70	65

### AGAINST THE RULE (Steep Axis 0° to 44°/136° to 180°)

PREOPERATIVE CYLINDER (Diopters)	Paired Incisions in Degrees of Arc					
	20 to 30 years old	31 to 40 years old	41 to 50 years old	51 to 60 years old	61 to 70 years old	71 to 80 years old
0.75	45	40	40	35	35	30
1.00	50	45	45	40	40	35
1.25	55	55	50	45	40	35
1.50	60	60	55	50	45	40
1.75	65	65	60	55	50	45
2.00	70	70	65	60	55	50
2.25	75	75	70	65	60	55
2.50	80	80	75	70	65	60
2.75	85	85	80	75	70	65
3.00	90	90	85	80	75	70

Blade's depth setting is at 90% of the thinnest pachymetry.

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the nomogram. When the LRI is superimposed upon the phaco tunnel, one creates the phaco incision by pressing the bottom surface of the keratome blade downward upon the outer or posterior edge of the LRI. The keratome is then advanced into the LRI at a plane parallel to the iris. This angulation will promote a dissection at mid-stromal depth, which will help ensure an adequately long tunnel and a self-sealing closure.

## Where

Properly centering the incisions over the steep corneal meridian is of the utmost importance. According to Euler's theorem, an axis deviation of 5°, 10°, or 15° will result in a 17%, 33%, or 50% reduction in effect, respectively.<sup>8</sup> This decrease holds true for both relaxing incisions and toric IOLs. Also, growing evidence supports the notion that significant cyclotorsion may occur when the patient assumes a supine position.<sup>9</sup> For this reason, most surgeons advocate placing an orientation mark at the 12:00- or 6:00-o'clock position on the limbus while the patient is upright. Doing so is particularly important when administering anesthesia by injection, which may result in unpredictable ocular rotation.

An additional tip for centering the relaxing incisions is to identify the steep meridian (plus cylinder axis) intraoperatively with some form of keratometry. The steep meridian over which the incisions are to be placed corresponds to the shorter axis of the reflected corneal mire. To mark the steep meridian, surgeons often use a Mendez ring or similar degree gauge, which is aligned with the previously placed limbal orientation mark, and then locate the axis of cylinder on the 360° gauge.

One should place the LRI at the most peripheral extent of clear corneal tissue, just inside the true surgical limbus—even in the presence of pannus. One may ignore bleeding if it occurs, because it will cease spontaneously. Placing the incisions farther out at the true surgical limbus will likely reduce their effect significantly due to both increased thickness of the tissue and a variation in its composition. LRIs are, therefore, really *intra*limbal in nature.

## How

It is important to hold the knife perpendicular to the corneal surface in order to achieve a consistent depth and effect and to avoid gaping of the incision. Adequate support of the hand and wrist is important, and one ought to hold the blade as if throwing a dart. In other words, one should be able to rotate the instrument between one's thumb and index finger as it advances. Typically, surgeons create the incisions on the right side of the globe with their right hand, and they use their left hand for incisions on the left side of the globe. In most cases, it is more efficient to pull the blade toward (versus away from) oneself.

## COMPLICATIONS

Even though LRIs are a safe and effective way of managing astigmatism at the time of cataract surgery, any surgical technique has potential complications (see *Potential Problems*). The most likely error involves incisions placed on the wrong axis, usually a 90° error with positioning upon the opposite, flat meridian. The error increases (likely doubles) the patient's preexisting cylinder. I recommend employing safety checks (eg, a written plan showing the proper orientation that is posted in the OR) to prevent this frustrating complication. Incisions are always placed upon the plus-cylinder axis and opposite to the minus-cylinder axis.

Although rare, corneal perforation is possible, potentially due to the blade's improper depth or as a result of a defect in the micrometer's mechanism. The latter problem may arise after repeated autoclaving and many sterilizing runs. Periodic inspection and calibration are warranted, even with preset single-depth knives. Unlike radial microperforations, circumferential punctures will rarely self-seal and will likely require the placement of temporary sutures.

## SUMMARY

The refinement of the refractive outcome may be the single most pressing challenge faced by today's cataract surgeons. Astigmatic relaxing incisions are the most common method used to address preexisting cylinder. Moving these incisions to an intralimbal location greatly reduces the incidence of complications and difficulties compared with astigmatic keratotomy. ■

*Louis "Skip" D. Nichamin, MD, is Medical Director of Laurel Eye Clinic in Brookville, Pennsylvania. Dr. Nichamin may be reached at (814) 849-8344; nichamin@laureleye.com.*



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