Incorporating refractive principles for better cataract surgery results

There is growing interest in incorporating and refining refractive elements into cataract surgery. Noel Alpins, MD, addresses some of these ideas in this column. Alpins, of Cheltenham, Australia, specializes in cataract and refractive surgery. He is creator of the ASSORT outcomes analysis software for general ophthalmic and refractive surgery techniques. He can be contacted at 7 Chesterville Road, Cheltenham, Victoria 3192 Australia.

—R. Bruce Wallace III, MD

by Noel A. Alpins, MD
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Recently, there has been considerable discussion about continued refractive refinements to cataract and implant surgery. Many surgeons may be asking themselves whether the refractive results of an operation as successful as small-incision cataract surgery can be improved significantly. Furthermore, if such improvement is possible, does the contemporary cataract surgeon need to make any major changes to the modus operandi of his or her surgical routine to achieve this? At the end of the day, is the gain worth the pain? The answer is yes—if we are seeking to further improve the refractive results for cataract patients.


Noel A. Alpins

Refractive vs. small-incision

How does refractive cataract surgery differ from what is commonly referred to as small-incision cataract surgery? By using the cataract incision as a refractive tool, the trend of making increasingly smaller incisions, which has occurred over the past decade, is reversed. Reducing the size of the incision seeks the least amount of surgically induced astigmatism—so-called astigmatic neutrality. The goal of refractive cataract surgery is astigmatic reduction, so that the cataract incision decreases existing astigmatism by inducing corneal flattening at the appropriate meridian. To do this, an incision of 5 mm or larger is necessary, with a smaller requirement for a foldable lens. When preoperative astigmatism exceeds 1 D, corneal change can be achieved by kerato-enhancement, employing additional astigmatic keratotomy incisions at the optimal axis.

Further differences become evident by the inclusion of the word "refractive" in the title, which recognizes the need for the refractive astigmatism value to be taken into account when determining the optimal axis for surgery. In the past, conventional cataract surgery principles have dictated that the axis be determined on the basis of shape, whether this be by keratometry or topography. When performing any refractive surgery, the differences in refractive and topographic astigmatism need to be addressed.

Placement of the incision

My goal when performing cataract or refractive surgery is to reduce existing corneal astigmatism and, where possible, create a more favorable orientation. When examining the effect of my 5.1-mm no-stitch scleral tunnel incision placed at the traditional 12-o'clock position, I found that it flattens the cornea by 0.7 D on average. Applying this information to the example in figure 1, the preoperative astigmatism of the eye would increase and be in a less favorable orientation—that is, toward against-the-rule for this eye. If this incision type had the same effect at all corneal meridians, then placing the incision temporally (Fig. 2) may improve the orientation of the astigmatism from its preoperative meridian. In this example, however, it would increase the amount of astigmatism.

Aligning the incision that flattens the cornea by 0.7 D with the steepest topographic axis at 40° (Fig. 3) is likely to reduce the corneal astigmatism, but would leave the resultant refractive astigmatism less favorably at axis 178°. This patient may be best served if the incision that flattens the cornea by 0.7 D were aligned on the refractive power axis at 20° (Fig. 4). This would achieve the optimal result by reducing both existing topographic and refractive astigmatism amounts and improving the orientation of the topographic axis from 40° to 72°. For patients with no significant preexisting astigmatism, an incision that is astigmatically neutral could be used, so as not to affect the astigmatic state of the eye.

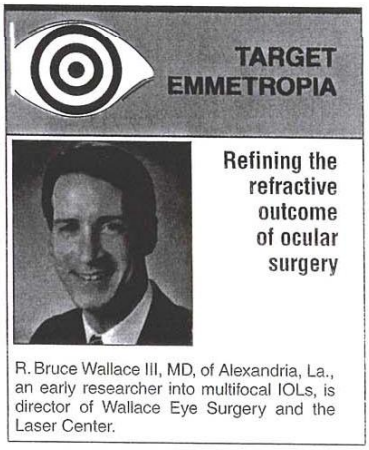
Rotating the surgical position to the appropriate axis for each patient requires the cooperation of the operating room staff. These minor inconveniences can be overcome by simple remedies, such as arranging the order of the day's surgery in a clockwise or counterclockwise sequence around the eyes.

Measuring an incision's effect

Performing surgery at varied corneal orientations requires that our analysis techniques provide the information necessary to understand the effect of the incisions. To plan refractive cataract surgery, we need to know how much flattening or even steepening might be expected from an incision when placed at a given meridian. Information about the past behavior of incisions is helpful in planning subsequent surgery. After the planning and completion of surgery, the results need to be analyzed according to where the cataract incision was intended to be placed. The conventional polar formulas of Naeser and Cravy deal only with incisions that lie on the vertical and horizontal meridia.

These two formulas provide useful information about whether there is a favorable with-the-rule or less favorable against-the-rule trend. However, concepts of incision performance can be simplified by looking at the behavior of cataract incisions in their flattening and steepening effect. This information is relevant to refractive surgical events in a wider sense, whether it be of the incisional or non-incisional type. Analyzing the behavior of incisions in this way provides a simpler and broader description of the surgical event than by using terms such as with- and against-the-wound.

Not only can the concepts be simplified in this way, so too can the formulas. Vector analysis is a complicated subject for which there are many formulas with different applications for particular purposes. No formula comprehensively explains everything, and



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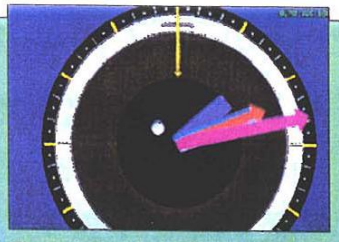

Figure 1—Incision at the superior pole. *When examining the effect of my 5.1-mm no-stitch scleral tunnel incision at the traditional 12-o'clock position, I found that it flattens the cornea by 0.7 D on average. In this example, the preop astigmatism would increase and be orientated toward against-the-rule for this eye.*

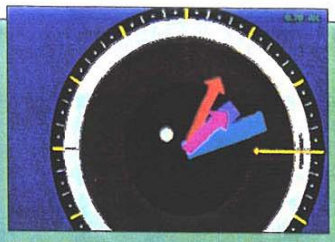

Figure 2—Incision at the temporal pole. *Although placing the incision temporally may improve the orientation of the astigmatism from its preoperative meridian, in this example it would increase the amount of astigmatism.*

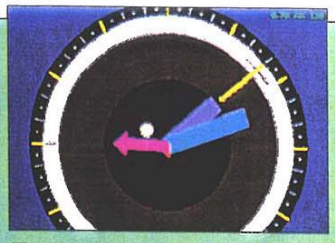

Figure 3—Incision at the steepest topographic axis. *Aligning the incision that flattens the cornea by 0.7 D with the steepest topographic axis at 40° is likely to reduce the corneal astigmatism, but would leave the resultant refractive astigmatism less favorably at axis 178°.*

Figure 4—Incision at the steepest refractive axis. *This patient may be best served if the incision that flattens the cornea by 0.7 D were aligned on the refractive power axis at 20°. This would reduce existing topographic and refractive astigmatism, improving the orientation of the topographic axis from 40° to 72°.*

having to use multiple formulas can make comparing results difficult.

Even when attempting to imitate the technique of a mentor, there is an inevitable personalization in the construction of a cataract incision. This personalization may increase as incisions move away from the traditional surgical operating position on the eye at 12 o'clock, revealing differing effects of the individual surgeon's own incisions at various positions on the eye. Applying information extrapolated from other surgeons' profiles is of limited value.

Differences

I have found that the same incision constructions and placements behave differently when sited at different meridia on the cornea. By analyzing my 5.1-mm scleral tunnel incisions, I find there are variations in the flattening effect on the cornea as the incision is placed closer to the horizontal axis. When analyzing my own flattening-steepening profile of recent refractive cataract surgery incisions examined in 15° groups around the eye, the flattening effect reduces the further away from the vertical meridian the incision is placed. Broader or narrower groupings may be preferred and can also be examined.

For example, if I were operating from the temporal side, to reduce significant against-the-rule astigmatism, I would probably either lengthen the incision or move it to a limbal or clear corneal site to increase the flattening effect. Alternatively, astigmatic keratotomy at the optimal axis could be performed with parameters such as length of arc, number of incisions and the optical zone chosen, derived from a favored nomogram.

Finding the optimal axis

So where is the optimal axis on which to place the cataract incision? Is it at the traditional and most convenient site for operating room flow—90°? Perhaps it lies at the temporal position, which provides improved visibility, generally giving better access to the eye and a with-

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the-rule trend for astigmatism change? Or is surgery most appropriate on the steepest corneal axis with a general trend to reduce preexisting keratometric astigmatism? Should we continue the push for incremental improvements by continuing efforts to minimize astigmatism further and truly target emmetropia?

All the above questions address differing approaches to cataract surgery, each with its own relevant priority. However, we are now discussing refractive cataract surgery—and in accordance with its name, refraction should be a consideration. In fact, the general principles of refractive surgery direct both refraction and topography to be part of the surgical decision-making process. In this way, the planning of refractive cataract surgery should optimally involve analysis of the expected result of surgery, rather than being guided by only one of the two preoperative astigmatism values.

Lenticular astigmatism is a term used by many either to describe or explain the differences between shape and refraction. However, it is only one of the factors responsible for these differences. If it were the sole cause, then all refractions would correspond to topography after cataract and implant surgery.

When the refractive cataract surgeon considers the placement of the incision, the decision of whether to place the incision in proximity to the refractive or keratometric axis will depend on an examination of the optimal result prior to performing the cataract surgery. The decision-making process is facilitated by knowing the behavioral history of the incision when placed around the cornea at each position and examining the target refractive and topographic astigmatism for the proposed placement of the incision.

Small-incision cataract surgery does not require as many case-by-case decisions, as the technology constantly searches for incisions that minimally disturb the corneal shape. This can be achieved by placing a 5- to 6-mm incision at the point of least disturbance and inserting a rigid lens, or striving to minimize the incision, which allows removal of the cataract and insertion of a foldable or injectable lens.

Refractive cataract surgery requires decisions on many variables for each case in order to maximize the surgical opportunity. These variables, such as the length of the incision, its placement in respect to the limbus and whether a suture is used, influence the astigmatism outcome in a predictable manner. The recent introduction of the concept of incorporating refraction and topography into the surgical plan enables refractive cataract surgery patients to benefit from the principles of optimization common to all forms of refractive surgery. ■