

Management of astigmatism after cataract surgery

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Postoperative astigmatism resulting from incisions in or adjacent to the cornea, a career long interest of the author, has recently become of more compelling interest to the general ophthalmologist, especially as it pertains to cataract surgery. All too frequently after successful extracapsular or phacoemulsification cataract surgery, corrected by a spherical intraocular lens, astigmatism induced by the healed cataract incision is the only factor preventing the uncorrected functional acuity anticipated by the patient. This problem, of everyday concern for the cataract surgeon, has resulted in significant modification of our cataract techniques, first to prevent post op astigmatism and should that fail to correct the postoperative residual.

To understand the new approaches for astigmatism prevention it is necessary to review the wound related mechanisms which have induced post cataract astigmatism.

In 1980 (Boyd Silver Anniversary Edition) and again in 1992 (Corneal astigmatism: etiology, prevention and management -Troutman and Buzard) I pointed out the importance of the limbal "Corneal Optical Ring", defined as the circular pyramidal shaped transition zone delimiting the cornea optically and anatomically from the sclera, in both the prevention and correction of incision related corneal astigmatism. The intact limbal ring prevents the steeper corneal curvature from assuming the flatter curvature of the sclera. An incision across or into the ring, the so-called "Surgical" limbus, compromises the limbal architecture in the incised sector. When supporting sutures decay or are removed, the ring circumference increases eccentrically and the corneal diameter increases progressively flattening the cornea in the meridian of the incision, so called "Creeping" astigmatism (Stark). The astigmatism

is further accentuated by the "Green's Tensor" phenomenon of "coupling" where the corneal curvature steepens in the meridian at 90 degrees *Poisson's ratio*. The longer the incision the greater is the potential for excessive, progressive postoperative astigmatism and the more unpredictable its secondary correction.

The popular *scleral tunnel incision* bisects the ring horizontally before entering the eye and better maintains limbal architecture. The shorter the incision the less the potential for induced astigmatism. Three mm long scleral tunnel incisions of up to 6.5 mm in width have been shown to remain *astigmatism neutral* with one horizontal or no sutures. However wider incisions, especially with shorter tunnels, will behave like incisions in the corneal ring. However, once the wound is healed, the corneal curvature stabilizes and secondary correction is more predictably performed.

Incisions in clear cornea avoid the ring entirely. Recently oblique 3.5 mm. incisions, which mandate the use of phaco and foldable lenses, have been shown by Fine to be *astigmatism neutral*. Wider 4 - 10 mm vertical profile incisions require suturing and meticulous full thickness closure. Mandatory wound compression induces corneal steepening and temporary astigmatism delaying the stable, *astigmatism neutral*, result until sutures are removed.

Sutures, when employed, should be of a non-absorbable elastic monofilament material which will hold the wound firmly across its full profile until healing occurs. Wound compression overcorrection should be monitored with a surgical keratometer. Postoperatively, concern about this mandatory overcorrection often prompts the surgeon to engage in the error of releasing "too tight" sutures before the wound is healed. Wound slippage and *creeping astigmatism* is the inevitable result. Interrupted sutures should not be cut earlier than three months from either corneal or limbal wounds or before six weeks from scleral tunnel

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incisions, opposing or single continuous sutures can be adjusted earlier to release tighter sectors without losing wound control.

Correction of preoperative astigmatism, of any degree, by incision or suture manipulation or by separate keratotomy should never be attempted at primary cataract surgery. The healing of such a doubly destabilized cornea assures an inaccurate, sometimes disastrous result.

The management of postop astigmatism begins at the first postoperative visit when the keratometer reading is compared to the preoperative finding. Optical correction verifies if a spherical error is combined with the astigmatic one. If acuity is compromised a temporary correction with the cylinder correction based on the keratometer findings may be given. The patient will be more accepting if, before the surgery, he or she has been told that in addition to sometimes inexact IOL power temporary post op astigmatism may occur, and if it should persist can be treated. After all sutures have been removed, serial keratometry and computerized topographic corneal mapping are used to determine when the wound is stable. At which time, the informed patient should be allowed to fully participate in the decision either to continue with optical correction or to have corrective surgery.

Surgical correction of an astigmatic residual can be complicated by a concomitant spherical error or can induce one and therefore may not eliminate entirely the need for correction. The patient may have multiple intractable problems responsible for asthenopic symptoms, anisometropia, an oculomotor disturbance, retinal or macular pathology, contraindicating astigmatism surgery.

Residual astigmatism, greater than 5 diopters, when due to a defective or dehiscent wound should be managed first by resuturing, revision or wedge (block) resection of the wound to control *creeping astigmatism* and stabilize the cornea. This must be verified by serial corneal topography before one of the paired symmetrical relaxing incisions techniques is used for correction of any residual. Relaxing incisions techniques, first developed by the author for correction of more central cir-

cumferentially induced post keratoplasty astigmatism, though the same in principle differ slightly in their application in the more peripheral sector induced astigmatism from the cataract incision.

For symptomatic astigmatism of 1 to 3 diopters, short (2-2,5 mm) transverse relaxing incisions (T-Cuts) can be employed. Exact axis, verified during surgery with a surgical keratometer, and centering the incisions within a 5 - 7 mm optical zone help to prevent the distortion and cross cylinder effects that can nullify results. Though overcorrection is rare, the effect increases directly in relation to the age of the patient and decreases directly in relation to the diameter of the optical zone, little effect being seen at 7 mm.

A better approach, which is readily applied up to 5 diopters of astigmatism, is my classical (arcuate shaped) relaxing incisions with or without compression (augmentation) sutures, accurately positioned under a surgical keratometer at the 7 or 8 mm optical zone, correction is varied by the width of the arcuate cut which induces less distortion and axis error than T-cuts. The paired incisions should not exceed 90° in width or in the older patient 60° where an increased correction effect is anticipated. Should more correction be required compression (augmentation) sutures are used which can if need be compensate 10 or more diopters of astigmatism.

A word of caution; the techniques I have described are prone to serious errors if not fully understood and meticulously applied to a stable cornea verified by serial topography. Instruments must be scrupulously maintained and calibrated to give reproducible results. Secondary surgery, redeepening, lengthening or resuturing of the incisions is frequently required for best results. I have not even discussed the combined use of spherical refractive surgery techniques to correct spherical residuals. Always consider that your patient's expectations may be better met by optical correction than by surgery.

Excimer laser photo ablation has only recently been applied to correct astigmatism. Though it shows promise to neutralize astigmatic residuals

with more accuracy and less morbidity than the techniques we have described today, it cannot prevent astigmatism, and at least for the short term is not available to manage your patient's immediate problem.

In cataract surgery prevention is the first and

best approach to avoid wound induced post-operative astigmatism. However should it occur in spite of the best intraoperative precautions, the primary postoperative management should be refractive. Finally, if careful evaluation and optical trial fail to alleviate the patients symptoms, surgical correction may be considered.