Refractive Surgery: A Glaucoma Specialist’s Perspective

A guide to pre-, intra-, and postoperative factors associated with glaucoma.

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Refractive surgery is generally performed on people in their third to fifth decade of life, while the prevalence of glaucoma increases as patients age, from 2% in those over 40 years old to greater than 10% in those over 75 years in predominantly white populations. Although there are several known risk factors for the development of glaucoma, it is impossible to predict who among the population undergoing refractive surgery will develop glaucoma later in their life.

Refractive surgeons must be aware of the pre-, intra-, and postoperative issues that are important for the management of patients from a glaucomatologist’s point of view. This knowledge will help refractive surgeons counsel patients, choose the appropriate surgery, and identify and effectively address postoperative problems. Similarly, glaucoma specialists must also understand these issues so that they can advise and manage patients who are considering or who have undergone refractive surgery.

THE IOP CHALLENGE

The glaucoma physician’s main concern with laser refractive surgery is that it affects the Goldmann applanation intraocular pressure (IOP) reading. Corneal thickness and biomechanics are altered due to laser refractive surgery, which may lead to an erroneous low IOP reading. IOP itself is not the defining factor for the diagnosis of glaucoma, as it is based on characteristic optic disc changes, often in the presence of corresponding visual field changes. However, high IOP is the most important risk factor for the development of glaucoma, and reducing IOP is the only therapeutic means available; hence, an accurate estimation of IOP is important in the management of these patients.

The presence of previous refractive surgery makes it difficult to set a target IOP for managing these patients. The target pressure must therefore be individualized based on the level of IOP at which glaucomatous damage has occurred or is progressing, rather than trying to achieve an absolute level of IOP. Although attempts have been made to correct for corneal thickness, there is no reliable correction factor to account for changes in corneal thickness and biomechanical properties after laser refractive surgery. The patient’s IOP before laser refractive surgery and after stabilization may therefore be a guide to correct for these changes and serve as a new baseline. Changes in the optic disc, nerve fiber layer, and visual fields serve as better parameters for monitoring patients who have had previous refractive surgery.

IOP measured by newer tonometers, such as the Pascal Dynamic Contour Tonometer (Ziemer Ophthalmic Systems AG, Port, Switzerland), may be less affected by these changes in the biomechanical properties of the cornea and may have a greater role for these patients in future.

PREOPERATIVE CONSIDERATIONS

Before surgery, the refractive surgeon must identify patients who have glaucoma or who are at increased risk for developing the disease. Patient history should elucidate any family history of glaucoma, as well as uveitis, ocular surgery, steroid use, and steroid-induced IOP rise.

Testing. Ocular examinations should include applanation tonometry; central corneal thickness and anterior chamber depth assessment; gonioscopy to identify occludable angles, especially in hyperopes; slit-lamp examination to identify pigment dispersion and pseudoexfoliation; and dilated funduscopy to evaluate the optic disc and retinal nerve fiber layer for glaucomatous damage. Particular attention should be paid to the size of the disc, the neuroretinal rim for focal or generalized thinning, the ISNT rule (inferior rim thickness ≥ superior rim ≥ nasal rim ≥ temporal rim), cup-to-disc ratio asymmetry greater than 0.2 between the optic discs, optic disc hemorrhages, baring of vessels, acquired pits, and peripapillary atrophy. Red-free light should be used to help identify nerve fiber layer defects. If these changes are not looked
for, they will not be detected.

**Risk factors.** Several factors increase a patient’s risk of glaucoma. These include high IOP, a positive family history of glaucoma (eightfold risk increase), African/Afro-Caribbean origin (four times higher prevalence), cup-to-disc ratio greater than 0.4, and central corneal thickness of less than 556 µm. Although normal optic disc cupping can range from 0 to 0.85, cupping greater than 0.6 is highly suggestive of glaucoma. In a recent population-based survey, a smaller vertical cup-to-disc ratio was found to be highly associated with an increased risk of undiagnosed glaucoma, highlighting the need for expert dilated stereoscopic disc assessment. Other potential risk factors include systemic hypertension, cardiovascular disease, myopia, migraine, and peripheral vasospasm.

**Diagnosis.** Visual field testing and disc and/or nerve fiber layer imaging should be performed for suspect or high-risk patients to aid diagnosis and to serve as a baseline for future reference. Referral to a glaucoma specialist may also be considered. If a patient is already known to have glaucoma, the decision for refractive surgery is based on the type of glaucoma, stage of disease, and preoperative control of IOP. The choice of surgery can also be influenced by these factors, with the patient’s glaucoma specialist involved in this decision.

**Myopia.** The most common indication for refractive surgery is myopia. High myopia is a risk factor for primary open-angle glaucoma. Some myopic discs are particularly difficult to interpret for diagnoses due to the presence of tilt, parapapillary atrophy, or an ill-defined rim. This makes monitoring for change in glaucoma problematic. Baseline disc photographs, disc and/or nerve fiber layer imaging, and visual fields are helpful.

**Hyperopia.** Patients with hyperopia are prone to primary angle-closure glaucoma and narrow occludable angles that should be identified by gonioscopy. In older patients who are likely to have reduced accommodation, refractive lens exchange may be considered. This will also help eliminate the risk of angle closure. Younger patients in whom there are narrow angles or iridotrabecular contact in two or more quadrants should be referred for further assessment and possible prophylactic laser iridotomy.

In those with high hyperopia for whom phakic IOLs are being considered, the mandatory requirement of at least 3 mm of anterior chamber depth should be adhered to. In particular, iris-fixated phakic IOLs are contraindicated in patients with less than 3.2 mm of anterior chamber depth and any angle abnormality, and sulcus-fixated phakic IOLs need at least 3 mm of anterior depth and an angle of at least grade 2.

**INTRAOPERATIVE CONSIDERATIONS**

When a suction ring is applied to the eye during LASIK, IOP rises over 65 mm Hg for 15 to 60 seconds. It has been reported that no significant change in visual fields occurs after LASIK in mild to moderate myopes less than 40 years of age who have no other risk factors for glaucoma. However, this sudden marked increase in IOP has been implicated as a cause for optic neuropathy and the development of visual field defects in those predisposed to glaucoma—such as those with family history or suspected glaucoma—and could be particularly detrimental to patients with established glucomatous damage. Hence, it is important that there is adequate preoperative history and examination. In these cases, surface ablation procedures such as PRK and LASIK may be safer. Similarly, the presence of a filtering bleb makes LASIK a contraindication due to the need to apply a suction ring at the limbus. LASIK, PRK, or lens-related procedures may be preferable in these circumstances.

Ophthalmic viscosurgical devices used during phakic IOL implantation should be thoroughly washed out of the eye to minimize the risk of early postoperative IOP rise. In patients undergoing phakic IOL implantation, there is an increased risk of pupil block; preoperative laser iridotomy, intraoperative surgical iridectomy, or ocutome iridectomy is indicated to reduce this risk. Small laser iridotomies can close with inflammation; therefore a laser iridotomy or preferably a surgical iridectomy of an adequate size should be considered.

Patients undergoing phakic IOL implantation of a rigid iris-fixated IOL, such as the Artisan (Ophtec BV, Groningen, Netherlands) or the Verisyse IOL (Abbott Medical Optics Inc., Santa Ana, California) should have a superior conjunctival peritomy large enough to accommodate a 5- to 6-mm scleral tunnel incision. This can compromise the results of future trabeculectomy surgery if it is needed. In glaucoma and suspected glaucoma cases, it may be preferable to implant a foldable iris-fixated phakic IOL such as the Artiflex/Veriflex (Ophtec BV/Abbott Medical Optics Inc.) or a sulcus-fixated lens such as the Visian ICL (STAAR Surgical, Monrovia, California) through a small clear-corneal incision.

**POSTOPERATIVE CONSIDERATIONS**

Steroids are used postoperatively after laser- and lens-related refractive procedures to reduce haze and inflammation and to treat diffuse lamellar keratitis. Steroids can cause a postoperative rise in IOP; particularly in those with preexisting glaucoma or a predisposition to the disease. This rise can sometimes be marked and can also lead to glucomatous visual loss and the need for a trabeculectomy in a small minority of patients.

Marked IOP rise has also been postulated to cause egress of fluid into the flap-bed interface. In these cases, there can
be a reduction in vision, change in refraction, epithelial edema, and high IOP. Applanation tonometry measurements of IOP can be misleadingly low in these cases due to the presence of interface fluid. Cessation of steroids and lowering the IOP with medical treatment can lead to the rapid resolution of this condition. However, if this condition is not recognized early, it can lead to the development of glaucomatous optic nerve damage. We have seen cases of mild corneal edema due to pressure rise misinterpreted as haze. In this situation, IOP should be measured by Schiotz tonometry, digital tonometry, Tonopen (Reichert Ophthalmic Instruments, Depew, New York), or applanation in the peripheral cornea outside the area of the flap. If there is doubt, a therapeutic trial of pressure lowering with clearing of the cornea is helpful.

Steroid-induced IOP rise occurs in less than 1% of patients after LASIK and approximately 1% to 2% after PRK or LASEK. In two studies of PRK for hyperopia,7 steroid-induced IOP was reported in more than 8% of patients. Steroids should be used for the shortest possible time, and consideration should be given to use of weaker steroids such fluorometholone and rimexolone or newer preparations such as loteprednol because these therapies are less likely to cause steroid-induced IOP rise.

Once patients are off topical steroids and the eye condition is stabilized after refractive surgery, IOP can serve as the new baseline. Treatments to reduce IOP in patients with and without previous refractive surgery are similar. Medical treatment with commonly used topical medications remains the first line. Acetazolamide can be particularly helpful in patients with acute IOP elevations. If IOP rise is intractable, and especially if there is evidence of ongoing glaucomatous damage, a drainage procedure such as trabeculectomy should be considered. If, prior to laser refractive surgery, patients had nerve fiber layer imaging with instruments that depend on corneal birefringence, such as the GDx VCC (Carl Zeiss Meditec, Jena, Germany), a new baseline image should be obtained after the corneal refractive procedure.

It is important that patients be aware that their IOP measurements can be erroneously low after a refractive procedure. They should mention their history of laser refractive surgery in subsequent eye examinations. It is possible that after correction of their refractive error patients may be lost to follow-up for routine eye testing by their eye care professionals; however, it is important that these patients be monitored regularly throughout life, particularly those at risk of or those with glaucoma.

Furthermore, data regarding baseline and postoperative examination should be made available to patients and their subsequent physicians. The provision of relevant pre- and postoperative data is similarly important for IOL power calculations for subsequent cataract surgery.

CONCLUSION

A close liaison between the refractive and glaucoma surgeons should be considered for patients who are at risk for the disease. Future developments in tonometry, imaging techniques, and genetics as well as refinements in refractive surgical techniques may help minimize risks and make refractive procedures safer for this group of patients.

**TAKE-HOME MESSAGE**

- Refractive surgeons must take pre-, intra-, and postoperative issues into consideration to help minimize the risks, choose appropriate surgery, and counsel patients with or at risk for glaucoma.
- The glaucoma physician’s main concern with refractive laser surgery is that it affects the Goldmann applanation IOP.