

# Case Report: Observation of Postoperative Refractive Status of Glaucoma Combined with Cataract and Irregular Astigmatism

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**How to cite this paper:** Lin, B., Chen, L.L. and Li, D.K. (2023) Case Report: Observation of Postoperative Refractive Status of Glaucoma Combined with Cataract and Irregular Astigmatism. *International Journal of Clinical Medicine*, 14, 429-437.  
<https://doi.org/10.4236/ijcm.2023.1410038>

**Received:** September 16, 2023

**Accepted:** October 22, 2023

**Published:** October 25, 2023

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## Abstract

**Significance:** So far, many scholars have studied the astigmatism caused by glaucoma surgery, but they cannot provide enough useful help for the clinic. When a patient has glaucoma, cataracts and irregular astigmatism at the same time, it is often difficult to achieve satisfactory results. **Purpose:** This study intends to describe a case of a patient with glaucoma, irregular astigmatism, and cataract who was successfully treated. Additionally, it can serve as a useful source of inspiration for the future care of patients like this. **Case Presentation:** A 24-year-old male with keratoconus in the past. He had undergone a corneal crosslinking operation in the right eye and a penetrating keratoplasty in the left eye due to his long history of keratoconus in both eyes. Right now, the keratoconus in that eye is stable. Unfortunately, he has now been diagnosed with open-angle glaucoma and complicated cataracts in both eyes, and he was admitted to our hospital for surgery. The right eye had significant irregular astigmatism, which was discovered during the preoperative assessment, and the implantation of a Toric intraocular lens was unable to produce good results. Finally, we chose to perform EXPRESS glaucoma drainage device implantation + phacoemulsification + intraocular lense (ZEISS CT ASPHINA 409MP) implantation. The patient had stable postoperative astigmatism with rule thanks to the traction effect of the scleral flap suture. Astigmatism was typically stable six months after surgery, and the corrected visual acuity with glasses had improved to 20/25. **Conclusion:** This patient suffers from cataracts, keratoconus, glaucoma, and irregular astigmatism. Due to the interconnectedness of these four disorders, simultaneous success is challenging. We realized that surgically induced astigmatism, frequently

affects vision early after filtering surgery for glaucoma patients. In the instance of this patient, we tightly sutured the scleral flap and using tractive action, established regular astigmatism. After the patient's astigmatism stabilized, optometry was given to correct the vision. This technique should result in much better visual acuity. Finally, it came to pass.

## Keywords

Glaucoma, Cataract, Keratoconus, Astigmatism, Filtering Surgery

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## 1. Introduction

Over the past ten years, we have seen the evolution of cataract surgery from the simple removal of the lens to a refractive technique intended to reduce the patient's dependence on glasses [1]. Additionally, postoperative astigmatism is a significant reason why intended emmetropia following cataract surgery does not occur [2] [3]. When astigmatism cannot be corrected, even if other aspects of the treatment are perfect, the patient still cannot achieve the best visual effect. According to studies, when cataracts are measured in China before surgery, more than one-tenth of individuals have astigmatism larger than 1.5D [4]. Femtosecond Astigmatic Keratotomy (AK) or steep axis incision are additional astigmatism correction options in addition to the implantation of toric intraocular lenses (IOLs) [5] [6]. Of course, difficulties are also possible, as the keratitis brought on by AK and the rotation of Toric IOL. Additionally, there is still debate concerning AK's efficacy [7]. As mentioned above, regular astigmatism can be corrected in a variety of ways, but irregular astigmatism is still a problem that cannot be solved by current technology. Surgically induced astigmatism (SIA) is typically brought on by filtering operations, and we hypothesized that this may have been caused by scleral flap release, suture tractive, or other variables. However, we have discovered that even non-penetrating glaucoma surgery, such as ultrasound cyclo-plasty (UCP), leaves patients with varying degrees of astigmatism [8]. Astigmatism management was usually difficult in patients undergoing cataract surgery together with a filtering operation; however, we have recently discovered that it is possible to achieve regular astigmatism in patients with SIA resulting from filtering surgery to further improve vision.

## 2. Case Report

A 24-year-old male patient had a 2-month increase in intraocular pressure (IOP) in his both eyes. When he was examined in another hospital two months prior, his IOP was 36.6/29.0mmHg in both of his eyes (1 mmHg = 0.133 kPa), and he was free of any symptoms, including painful eyes, photophobia, lacrimation, headaches, nausea, or vomiting. He was eventually given the diagnosis of "bino-cular glaucoma" and was prescribed Brinzolamide and Bromonidine Eye Drops to regulate the IOP in both of his eyes. But it wasn't very effective. He eventually

visited our hospital and we found that he already had complicated cataracts. So he decided to accept a glaucoma cataract surgery in his right eye.

The patient had significant binocular myopia and a long history of keratoconus. He underwent a corneal crosslinking procedure and penetrating keratoplasty in his right and left eyes, respectively, seven years ago. Since the patient was treated at another hospital and medical records were not properly kept, the exact course of treatment is unclear. However, the patient reported no significant change in corneal thickness and no corneal rejection after reviews. The keratoconus in both eyes is currently stable.

The right eye's uncorrected visual acuity (UCVA) was 20/1000. Under 4 medications, the IOP was 26.9 mmHg after admission to hospital, and the residual refraction was 13.00 – 3.00 × 15 (20/250). The center cornea was thinned like an awl. Although there was no Vogt's striae visible on the cornea, Munson's sign was positive. And the conjunctiva was slightly engorged. The posterior capsule opacification of the cataract is evident, and it is hazy and gray. The retina is flat, and the optic disc is a pale tint. The UCVA in the left eye was counting fingers (CF) 10 cm. The IOP was 14.2 mmHg under 2 medications, and the residual refraction was –6.00 – 4.00 × 80 (20/2000). The corneal transplant is transparent, and some sutures are still in place. The vitreous space and retina were obscured by the cataract's grayish-white opacity, which was more noticeable than that in the right eye. See **Figure 1** for an eyes condition.

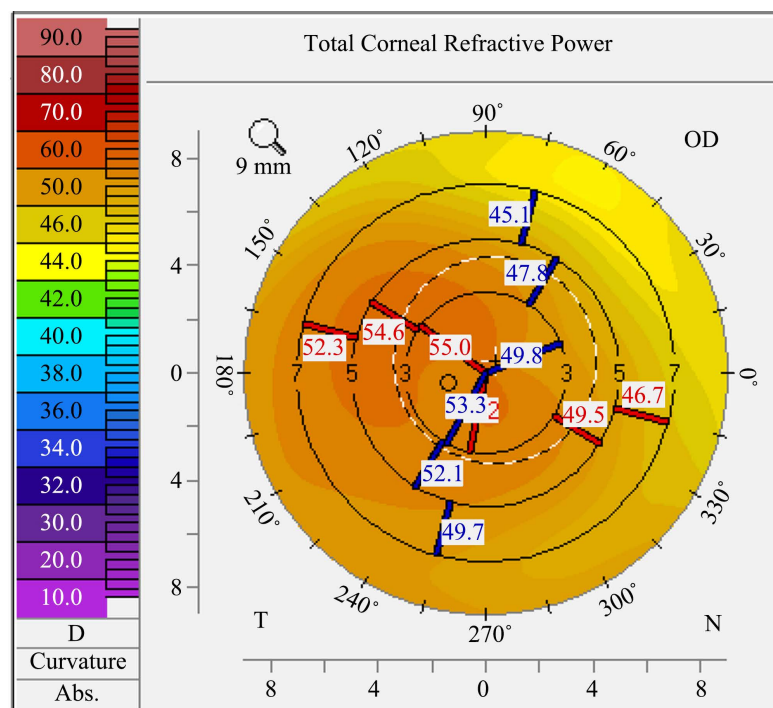
After being admitted, we conducted a number of tests to further determine the need for surgery and to get ready for it. Only a small amount of residual field of vision was found in the right eye's center, according to the Perimetry (Humphrey, Carl Zeiss Meditec Inc, Germany). OCT (whole eye OCT, Svisio-nimaging Inc, China) revealed expansion of C/D, weakening of the Retinal Nerve Fiber Layer (RNFL), atrophy of the Ganglion Cell Layer (GCL) in the macular region of the right eye, and ambiguous scanning of the left eye. Combined with IOP, which cannot be controlled by medication, these suggest that filtering surgery is needed to further reduce IOP and protect the optic nerve. According to IOL-Master (IOL-Master 700, Carl Zeiss Meditec Inc, Germany), the right eye's astigmatism is 3.23D@103°. The Corneal Topographer (Pentacam,



**Figure 1.** The cataracts are cloudy in both eyes and we even can find that corneas are not regular easily.

OCULUS Inc, Germany) also indicated the right eye may have 1.9D@136° of irregular astigmatism (Figure 2). There was still a significant diopter difference even after multiple measurements of the two data under the stable tear film condition, but the axial consistency was adequate. These suggest that the patient's corneal astigmatism is likely to be irregular, and we need to focus on the specific image of his corneal topographic map.

Due to this circumstance, the following ideas should be taken into account: 1) The patient, a young male, needs more requirements for his future life and to develop a long-term plan for his postoperative eyesight. 2) Due to his high myopia, the diopter deviation should be taken into account when calculating the IOL [9], and the change in eye length brought on by the reduction in IOP following the combined surgery for glaucoma and cataract will also affect the diopter. 3) The right eye has a history of keratoconus, the cornea is thin, the IOP was high when the patient was admitted, causing the corneal surface to be somewhat full, and the corneal curvature was measured incorrectly. 4) The majority of glaucoma filtering procedures result in significant amounts of SIA. In the past, astigmatism patients were frequently advised to combine cataract surgery with intracervical trabeculectomy or XEN stent drainage (Allergan Inc, USA) implantation. In order to further enhance postoperative eyesight and visual quality, it can lower the formation of SIA and make it easier to implant a Toric IOL intraoperatively. However, the patient also had keratoconus, and their astigmatism was irregular, thus the previous method's surgical correction included a high chance of refractive error. This puts us in a difficult situation.



**Figure 2.** The corneal topographic map shows irregular astigmatism before surgery, in which steep axes and flat axes are not perpendicular to each other in central space.

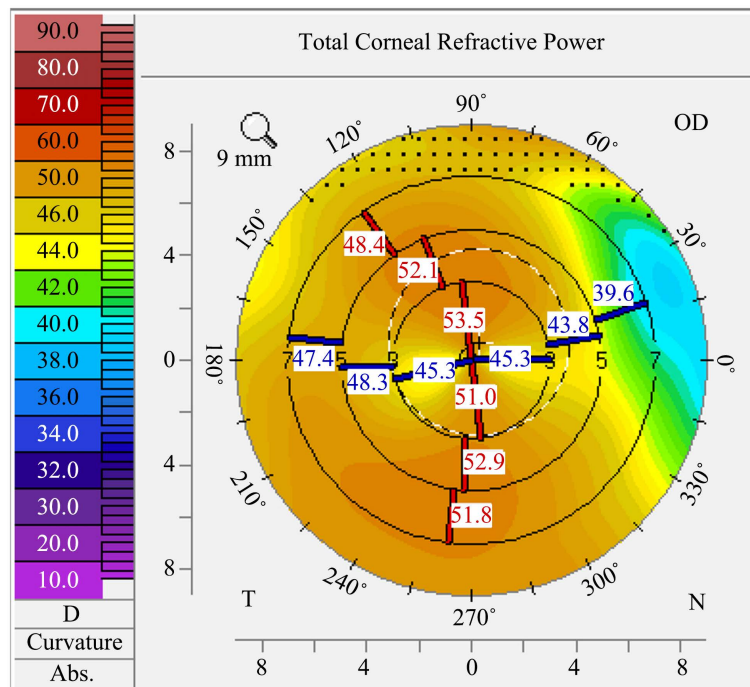
We collect that early on following filtration surgery; patients frequently experience fluctuations in UCVA. This is because filtering surgery results in a bigger SIA [10], and early postoperative tear film instability [11]. Patients frequently report that their UCVA fluctuates, sometimes for the better and other times for the worse. The patient's central-temporal side cornea, which had a maximum thickness of only 424  $\mu\text{m}$ , was mostly to blame for the irregular astigmatism. When compared to typical corneas with the same diopter, irregular astigmatism has inferior visual quality [12]. To further enhance postoperative vision quality using the SIA created by filtration surgery, we, therefore, chose to transform the right eye into standard astigmatism. Because the scleral flap was situated on the corneal sclera's top edge. The patient could undoubtedly receive optical service with greater safety and ease. Even though other studies claim that SIA from filtering surgery may flatten out three months after surgery and that astigmatism in patients would roughly recover to the preoperative state. With a little attention to the stitches, which are tighter than before, we think we can get good outcomes.

We negotiated the operation plan with the patient, which was approved and agreed upon by him. Meanwhile, the patient indicated that he had Monocular vision in his right eye and hoped to take this opportunity to improve UCVA as much as possible to provide convenience in life. We calculated the reserved  $-3.79\text{D}$  of ZEISS CT ASPHINA 409 MP (Carl Zeiss Meditec Inc, Germany) by the Barrett formula to avoid the deviation of the diopter. At the same time, the plate IOL further provides the patient with pseudophakic accommodation [13] after surgery to achieve a better visual state, hoping that the patient can achieve a life state without wearing glasses after surgery basically.

As with other patients, a 4 mm by 3 mm scleral flap was made directly above the corneal limbus. The cataract surgery is then performed under a 1.8 mm corneal incision, which minimizes SIA interference from the corneal incision. Next we implanted an EXPRESS drainage device under the scleral flap, and unlike usual we had three stitches on the free side of the scleral flap to create a stronger pull force. In this procedure we usually make a stitch in each corner of the scleral flap before. Finally, the conjunctiva is sutured.

The patient's right eye had a UCVA of 20/333 on the second day following surgery. The residual refraction was  $+4.50 - 6.00 \times 180$  (20/50) and the IOP was 11.3 mmHg without medication. According to the Corneal Topographer, the astigmatism in the cornea after surgery was more regular than it was before, but it increased to  $6.4\text{D}@95^\circ$  (Figure 3), which was thought to be caused by overstretching the scleral flap suture. However, the patient said that he had no discomfort in his right eye and that his visual acuity has improved. Considering the unstable refractive status of the patient at least in the short run, he was discharged from the hospital. We followed him up in the outpatient clinic.

The conjunctival sutures were removed one month after surgery, and UCVA gradually increased during the regular review. The UCVA was 20/50 in the right eye, and the corneal topographer indicated that astigmatism slightly changed to



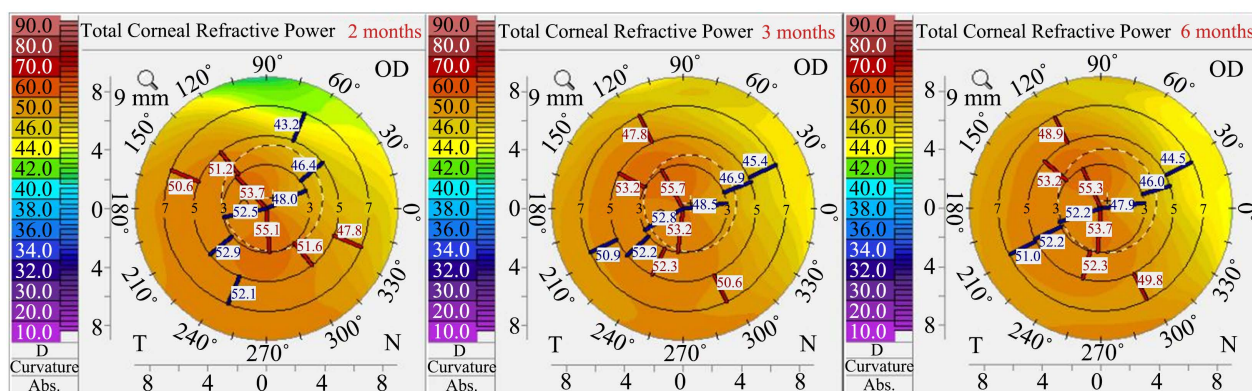
**Figure 3.** The astigmatism was more regular than before through the corneal topographic map on the second day after surgery.

the preoperative corneal morphology at the reexamination 2 months after the operation. The direction of the steep axis slightly changed from  $95^\circ$  on the second day after surgery to the preoperative direction, but the regularity of astigmatism was still significantly improved compared with the preoperative direction. The astigmatism was  $2.6\text{D}@112.6^\circ$  (K1: 50.0D, K2: 52.6D). The UCVA of the right eye was 20/25 after 3 months, and the Corneal Topographer showed that astigmatism was  $2.9\text{D}@107.8^\circ$  (K1: 50.2D, K2: 53.1D). It was roughly the same as that at 2 months after surgery.

The outpatient reexamination 6 months after surgery showed that the UCVA of the right eye was 20/32, and the residual refraction was  $+0.50 - 3.50 \times 5$  (20/25). The Corneal Topographer still suggested that astigmatism with rule regularly, showing  $3.7\text{D}@103.6^\circ$ . Perfect vision can be achieved with the glasses, and the patient is satisfied with it. The IOP was between 10.3 mmHg and 15.9 mmHg steady during the postoperative review without drugs. The astigmatism changes are shown in **Figure 4**.

### 3. Discussion

This is a complex patient with a history of keratoconus and corneal crosslinking operation of the right eye. Currently, he has high IOP in his right eye and a cloudy cataract. And he hopes to improve his vision while controlling the IOP through surgery. Additionally, the patient has good expectations for vision and his right eye is currently monocular, which presents significant challenges to both the accuracy of preoperative measurement and the accuracy of postoperative



**Figure 4.** The corneal topographic map on the 2, 3, 6 months after surgery.

target diopter prediction. The patient underwent a series of cataract-related examinations before surgery under poor IOP, in which the eyeball was relatively full, especially the patient's cornea was thin. As a result, astigmatism and corneal diopter in patients may be underestimated due to a wider radius of corneal curvature than that under normal IOP. We were reluctant to utilize Toric IOLs because Olsen T's study revealed that every 1 mm change in corneal curvature radius would result in a 5.7D diopter change [14]. Because the Barrett formula is accurate in calculating varied eyeball axes [9], anterior chamber depths, and corneal curvatures, it is employed in this instance. The patient's long history of extreme myopia led to a goal diopter of  $-3.79D$ , which was chosen to prevent postoperative refractive drift [15].

In general, glaucoma filtering surgery causes an increase in astigmatism; this is particularly true for keratoconus patients, whose postoperative alterations in corneal curvature are more noticeable. Fortunately, the patient's right eye had already undergone a corneal crosslinking operation, and his condition is now stable. After surgery, the patient finally achieved perfect UCVA and regular astigmatism.

#### 4. Conclusion

In this instance, we discovered that the tugging action of the scleral flap during the filtration procedure can cause irregular corneal astigmatism in glaucoma patients with cataracts to produce regular astigmatism with rule. Individual eye surgeons can determine their own SIA for filtering surgery based on their surgical practices. In a recent study, Gibbons A recommended that to further enhance postoperative vision quality in glaucoma patients, surgeons should be encouraged to get personalized SIA measures for filtration surgery [16]. For patients with regular astigmatism, we can obtain more accurate postoperative visual effects through more accurate SIA calculations. For patients with irregular astigmatism that cannot be corrected for various reasons, we can transform the patient's cornea into regular astigmatism first in the way mentioned in this paper, and then further achieve the best visual effect through astigmatism correc-

tion. This is also meaningful for the future use of Toric IOL in cataract surgery in such patients.

### Conflicts of Interest

All the authors declared that they had no conflict of interest.

### Authors' Contributions

BL is responsible for tracking the patient's treatment history after admission and completing the preoperative examination. When a number of abnormalities were found in the preoperative examination of the patient, BL, LLC and DKL searched relevant literature together and discussed the final treatment plan. The surgery was performed by DKL with LLC as an assistant. Postoperative review and data collection were completed by BL and DKL respectively.

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