Case report

Cataract surgery in a patient with an angle gamma due to macular heterotopia

Rie Hoshikawa, Yoshihiko Iida, Takushi Kawamori, Nobuyuki Shoji

A R T I C L E  I N F O

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A B S T R A C T

Purpose: We report a case of cataract surgery in a patient with a detectable angle gamma due to macular heterotopia.

Observation: A 48-year-old man had angle gamma due to macular heterotopia secondary to retinopathy of prematurity. The preoperative corrected distance visual acuity was 20/32 in the right eye and 20/200 in the left eye. Ocular deviation was esotropic at an angle of 70−80 prism diopter. Only the right eye was capable of fixing due to the amblyopia in the left eye. The preoperative root mean square was measured (cornea: 1.32 μm, total: 1.64 μm in ordinary fixation position, cornea: 0.36 μm, total: 3.40 μm in pupil center position). The total aberration was lower in the ordinary fixation position than in the pupil center position. Corneal refractive power was 41.75 D in the ordinary fixation position and 43.05 D in the pupil center position. The axial lengths were 22.25 and 22.54 mm, respectively. We selected the VA60BBR intraocular lens (IOL) at +28.00 D based on the targeted fixation state. Target refraction was −1.32 D. The postoperative course was favorable, and the resulting visual acuity was 20/40.

Conclusion: We report a case of cataract surgery on a patient with an angle gamma due to macular heterotopia. The postoperative course was favorable, and the patient's satisfaction was good considering that we selected the IOL's postoperative fixation state to meet the patient's occupational demands.

1. Introduction

Macular traction secondary to retinopathy of prematurity (ROP) can cause pseudostrabismus, where a positive or negative angle gamma (the angle formed between the visual and optical axes) can be observed. A positive angle gamma occurs when the macula is deflected temporally, while a negative angle gamma occurs when the macula is deflected nasally.

In patients with a detectable angle gamma, the visual axis passes outside the optical center of the cornea and crystalline lens rather than through the center of the pupil.

Thus, in a patient with an angle gamma, changes in the optical system may be present, which could necessitate surgical intervention in the form of cataract surgery and the need for an intraocular lens (IOL).

We report a case of cataract surgery in a patient with an angle gamma due to macular heterotopia secondary to ROP.

2. Case report

2.1. Case: a 48-year old man

Anamnesis: ROP with amblyopia of the left eye. Both eyes were treated using photocoagulation (details are unavailable).

History of present illness: The patient was diagnosed with diabetes 10 years ago.

He was referred to our hospital for careful examination of diabetic retinopathy. On examination, the right eye refraction was +0.25/−5.00 × 125, with the best spherical corrected visual acuity (BSCVA) of 20/32. The left eye refraction was −2.00/−1.25 × 25, with BSCVA of 20/200.

Both eyes had cataracts, with the right eye at grade II-III (Emery-Little classification) and the left eye at grade II. The right eye showed a shallow anterior chamber, with a temporal macular shift (Fig. 1) and a positive angle gamma of more than 30 prism diopter, which was attributed to macular heterotopia (Fig. 2). Diabetic retinopathy was noted.
in the left eye (B1). Right eye was diabetic retinopathy-free yet.

There were no disorders of eye movements. However, ocular deviation was present with an esotropia of the right eye at an angle of $70^\circ \sim 80^\circ$ prism diopter, he had no diplopia. Only the right eye was capable of fixating due to the amblyopia in the left eye.

We decided to perform cataract surgery of right eye to treat the diabetic retinopathy and to correct the narrow angle that made mydriasis difficult, in compliance with the patient's personal preferences.

High order aberrations in the center were measured at a diameter of 6 mm with KR-1W (Topcon Corp., Tokyo, Japan). The preoperative root mean square (RMS) was measured (cornea: 1.32 $\mu$m, total: 1.64 $\mu$m in the ordinary fixation position (Fig. 3-a), cornea: 0.36 $\mu$m, total: 3.40 $\mu$m

| Table 1 |
| --- |
| Preoperative root mean square (KR-1W, Topcon Corp.). |

| Ordinary fixation position | Pupil center position |
| --- | --- |
| Cornea 1.32$\mu$m (coma like: 1.04, spherical like: 0.80) | 0.36$\mu$m (coma like: 0.26, spherical like: 0.25) |
| Total 1.65$\mu$m (coma like: 1.46, spherical like: 0.78) | 3.40$\mu$m (coma like: 3.23, spherical like: 1.07) |

Fig. 1. Panorama photograph. a. Right eye: Macular heterotopia, b. Left eye: Diabetic retinopathy (B1). Macular was deflected temporally in right eye. Diabetic retinopathy was noted and macular was no deflected in the left eye.

Fig. 2. Ocular deviation photograph. a. Primary position, b. Right eye fixation, c. Left eye fixation. Right eye shows positive angle gamma (b), left eye was none (c). Left eye was amblyopic, thus only the right eye was capable of fixation (a).

Fig. 3. Fixation state in right eye. a. Ordinary fixation position b. pupil center position.
in the central pupil position (Fig. 3-b)). The total aberration was lower in the ordinary fixation position than in the pupil center position (Table 1).

Preoperative measurements were performed using the IOL Master 700 (Carl Zeiss Meditec, Inc., Dublin, CA, USA) in the ordinary fixation and pupil center positions (Table 2). Corneal refractive power was 41.75 D in the ordinary fixation position and 43.05 D in the pupil center position. The axial lengths were 22.25 and 22.54 mm, respectively.

The spherical mono-focal IOL VA60BBR (HOYA Corp., Tokyo, Japan) was selected based on its centering error and tilt. The desired postoperative refraction status was myopia, in light of the patient’s occupational demands and preoperative refraction. The IOL power was +28.00 D, functioning well in both positions to meet the patient’s visual demands (ordinary fixation position: −1.32 D, pupil center position: −3.03 D). IOL power was calculated by SRK/T.

The IOL was implanted using the bag-in-the-lens technique. There were no postoperative complications. At 3 months postoperatively, refraction was −1.00/−1.00 × 140°, with BSCVA of 20/40 and an uncorrected distance VA of 20/63. Corneal RMS remained the same 3 months postoperatively; however, the total RMS was increased in the ordinary fixation position (2.72 μm) than in the pupil center position (0.69 μm; Table 3).

VA was measured after correction using a hard contact lens (HCL), taking into consideration the effect of corneal aberration. The correct distance VA with HCL was improved 20/25.

The postoperative BSCVA was poor; however, the patient was able to view computer screens closely, meeting his occupational demands, and was satisfied with the overall result.

### 3. Discussion

In this case, the cornea and crystalline lens were tilted and decentered because of the large angle gamma due to macular heterotopia. Topography measured with ATLAS (Carl Zeiss Meditec Inc.) in the ordinary fixation position showed irregular astigmatism due to the visual axis passing through the nasal cornea, not the corneal center (Fig. 4). Thus, the corneal RMS was higher in the ordinary fixation position than in the pupil center position. However, the total RMS was lower in the ordinary fixation position than in the pupil center position.

The crystalline lens compensates for the corneal aberrations in order to produce improved retinal images, but this compensation decreases with age.

In this case, this compensation was offset because of the macula heterotopia secondary to ROP in childhood, leading to a lower total RMS in the ordinary fixation position.

Preoperative measurements were recorded in the ordinary fixation and pupil center positions. The values of corneal refractive power and axial lengths differed according to the fixation position.

We selected the spherical mono-focal IOL VA60BBR (HOYA Corp., Tokyo, Japan) based on its centering error and tilt. Numerous studies have reported on IOL decentration and tilt. Holladay reported that an aspheric IOL decentered over 0.4 mm and tilted greater than 7° would fall below the optical performance of a conventional spherical IOL. Therefore, the spherical monofocal IOL was selected, considering its centering error and tilt.

In our case, it was challenging to determine the values at ordinary fixation and pupil center positions to use in our IOL power calculations. With no precedent, we could not predict a postoperative target. Thus, we calculated values in both ordinary fixation and pupil center positions and selected the IOL power in both cases to produce a myopic status postoperatively. Postoperative refraction was −1.50 D. The validity of calculated values at the ordinary fixation position is likely to be different at angles of gamma.

The BSCVA deteriorated postoperatively. At 3 months postoperatively, RMS was increased in the ordinary fixation position. The increased aberration because of the compensation of the corneal aberration by the crystalline lens, which was loose, decentered, and tilted at the time of cataract surgery and had a high IOL power (+28.00 D). VA was measured after correction using an HCL, considering the effect of corneal aberration. The corrected distance VA with HCL was improved 20/25. The patient was able to view his computer screen at work, meeting his occupational demands, and was satisfied with the overall results. We believe that his satisfaction was because of the improvement in contrast and the correction of the low-order aberration because of cataract surgery.

The development of individualized IOLs that cancel out corneal coma aberrations are anticipated in the future.

### 4. Conclusion

We report our experience with performing cataract surgery on a patient with an angle gamma due to macular heterotopia. The postoperative course was favorable and patient satisfaction was good. The IOL should be selected based on the patient’s fixation state.

### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

### Patient consent

Patient consent was obtained in oral for this case report.

### Founding

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### Conflicts of interest

Authors (RH, YI, TK) have nothing to disclose.

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Fig. 4. Topography (ATLAS, Carl Zeiss Meditec Inc.). a. Ordinary fixation position Steep K: 43.77 D at 74°. Flat K: 39.60 D at 164°. Astigmatism: 4.17 D. b. Pupil center position Steep K: 44.46 D at 53°. Flat K: 41.55 D at 143°. Astigmatism: 2.91 D. In the ordinary fixation position showed irregular astigmatism (a), in pupil center position showed regular astigmatism (b).

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