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Brief Report

Myopic shift in a pseudophakic eye with an accommodating IOL following vitrectomy with gas tamponade

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ABSTRACT

Purpose: To report the case of a patient with Crystalens, an accommodating posterior-chamber intraocular lens (IOL), who experienced a myopic shift following subsequent vitrectomy with gas tamponade. We propose a hypothesis as to why this myopic shift occurred and analyze its validity based on current literature.

Observations: A patient had cataract surgery with implantation of a Crystalens AT-50AO +21D. Preoperative A-scan measured anterior chamber depth (ACD) to be 3.69 mm. The refraction was emmetropic following cataract surgery. Nine months later, the patient required pars plana vitrectomy with gas tamponade for a rhegmatogenous retinal detachment, followed by vitrectomy, membrane peel, and air/fluid exchange for epiretinal membrane. The retinal repair was anatomically successful, however, the patient experienced a −1.0 D myopic shift. ACD measurement following vitrectomy was 5.08 mm.

Conclusions and importance: Myopic shift following vitrectomy with gas tamponade in pseudophakic eyes is widely reported. This patient's myopic shift was assumed due to anterior movement of the Crystalens caused by a gas bubble placed during retinal detachment repair as this is the prevailing theory in the literature [1]. However, a comparison of the patient's ACD measurements does not support the above hypothesis. Further study is needed to determine the mechanism of myopic shift seen in pseudophakic patients following vitrectomy, specifically those with gas.

1. Introduction

This report focuses on a patient who underwent uneventful Femtosecond laser assisted cataract removal of the right eye with implantation of a Crystalens AT-50AO +21D with capsular tension ring. Nine months postoperatively, the patient presented with rhegmatogenous retinal detachment of his right eye, which was treated successfully with vitrectomy gas tamponade and endolaser. The post-operative development of an epiretinal membrane required a second vitrectomy with membrane peeling and air-fluid exchange. His visual acuity testing following vitrectomy demonstrated a myopic shift. The precise cause of this myopic shift is unknown; one possibility is that the gas in the vitreous cavity caused anterior displacement of the lens. Additionally, the type of IOL implanted, Crystalens, is an accommodating IOL, which is thought to sit more posteriorly in the lens capsular bag, which may be predisposed to lens displacement.

2. Case report

A 51-year-old Caucasian male underwent uneventful Femtosecond laser assisted cataract removal of his right eye, with implantation of a Crystalens AT-50AO +21D and a capsular tension ring (CTR). The CTR was used to ensure stability of the Crystalens following implantation. Since some patients manifest loose zonules, and because of varying degrees of capsular contraction that occurs during healing, the CTR is thought to be beneficial in preventing tilting of the IOL. Specifically, in the case of a Crystalens, the CTR was used to minimize risk of developing a Z syndrome Pre-operative measurement of the anterior chamber depth (ACD) at this time was 3.69 mm. Past ophthalmic history is significant for myopia and LASIK in both eyes and cataract surgery on the left eye one-year prior with an Abbott ZMBOO +20D implant. Pertinent family history is significant for retinal detachment following cataract surgery. The patient's postoperative exam the day after surgery revealed uncorrected visual acuity of 20/20 in his right eye. Development of bilateral posterior capsule opacity required YAG capsulotomies. Eight-month post-YAG showed visual acuity of 20/20

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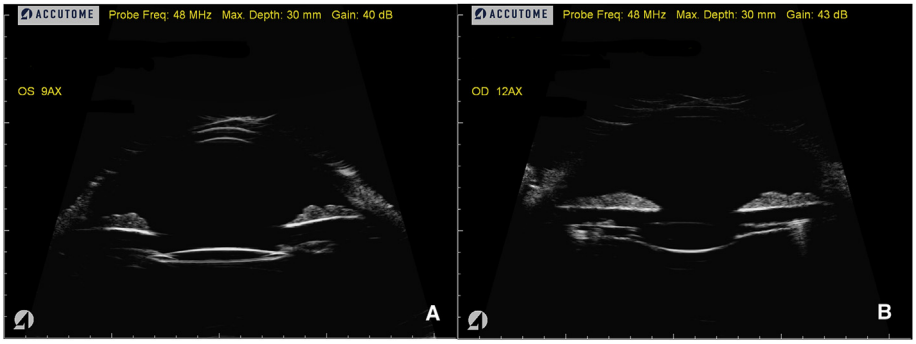

Fig. 1. (a) UBM of Tecnis IOL in OS showing its more posterior position than the Crystalens in OD (b) UBM of Crystalens in OD demonstrating proper orientation and lack of Z syndrome.

without correction in both eyes.

Eight months later, the patient presented with a 2-week history of floaters in his right eye. The patient was referred for retinal evaluation and was diagnosed with a retinal tear of his right eye, which was treated with barrier laser, and visual acuity one month later was 20/20 in both eyes without correction.

Two months later, the patient was referred to another retinal specialist for a second opinion due to persistent floaters in his right eye. Exam revealed a walled off retinal detachment with a single horseshoe tear and lattice degeneration in his right eye. Observation was recommended. Seven weeks later, the patient presented with increasing floaters for two days. Visual acuity was 20/20 in both eyes without correction, however, exam revealed a macula-on retinal detachment in the right eye with multiple breaks. The patient underwent retinal detachment repair with pars plana vitrectomy, endolaser, and gas-fluid exchange with 24% sulfur hexafluoride (SF6). Once the gas absorbed, vision was 20/30+, and exam revealed anatomically successful surgery.

The patient's uncorrected vision improved to 20/20 and remained stable in both eyes for the following nine months, although a mild epiretinal membrane was present in the right eye. The patient self-reported an improvement in near vision over this time period. Eight months after retinal detachment repair, the patient presented with slightly worsening distance vision. Uncorrected visual acuity was 20/25 -2 and 20/25 in right and left eye, respectively. Exam revealed worsening epiretinal membrane and loss of foveal depression in right eye. The patient complained of significant distortion of vision in the right eye.

The patient underwent vitrectomy with epiretinal membrane peel with partial air-fluid exchange in the right eye. The surgery was anatomically successful. Post-operative visual acuity in his right eye measured 20/100 + 1 without correction and 20/30 + 2 with correction in right eye.

The patient's vision steadily improved over the following two months. Visual acuity was 20/40 and 20/20 uncorrected in right and left eye, respectively. 20/20 vision was achieved in right eye with refraction of -0.75, -0.50×124. Three months later, A-scan of the right eye measured ACD as 5.08 mm.

3. Discussion

This is a case of a pseudophakic patient who experienced a myopic shift following rhegmatogenous retinal detachment repair with pars plana vitrectomy, endolaser, and gas tamponade. The prevailing hypothesis assumes that anterior pressure from a gas bubble causes anterior displacement of the Crystalens. Gas introduction into the vitreous cavity increases surface tension and applies buoyant force, causing the IOL to move forward, and thus reducing the ACD.[2] Others have reported myopic shift in phakic patients who undergo combined cataract and vitrectomy surgeries with gas tamponade. It is generally accepted that vitrectomy with gas tamponade causes a greater myopic shift than without, but there is disagreement as to how and why this shift happens.[7,10] Any attempts to reduce this myopic effect with either IOL design or surgical technique seem to be rare.[3,8] Interestingly, there is much less data on refractive changes, particularly myopic shift, that may occur in pseudophakic patients who undergo subsequent vitrectomy with the use of gas tamponade, as seen in the present patient.

There are several factors influencing refractive outcome in pseudophakic eyes, including: axial length, changes in lens position, corneal curvature, anterior chamber depth, use of intraocular gas tamponade, and IOL type.[4] There is conflicting evidence as to the change in ACD in pseudophakic eyes following vitrectomy with the use of gas. One study has shown that in patients in which gas tamponade was used, the ACD was statistically significantly reduced,[9] while others have found no change in ACD when vitrectomy is performed regardless of the use of gas.[1,2]

On average, the ACD increases by 1.4 mm following cataract surgery.[2] The patient's ACD prior to his Crystalens implantation was 3.69 mm. It can then be estimated that his ACD following cataract surgery and prior to pars plana vitrectomy was about 5.09 mm (3.69 mm + 1.4 mm), corresponding to an ACD measurement of 5.08 mm, found 15 months following pars plana vitrectomy with gas tamponade and 4 months following his second vitrectomy for correction of epiretinal membrane. It has been estimated that a 0.033 mm ± 0.060 (SD) anterior-posterior shift in lens position correlates to a 0.05 diopter change in lens power.[5] This patient's postoperative refractive error measured −1.0 D, while the estimated lens position changed only 0.01 mm in the anterior direction. Therefore, it is likely that change in lens position does not completely explain the patient's myopic shift.[6]

Ultrasound biomicroscopy (UBM) was done to ensure proper orientation of the lens in the eye and absence of a Z syndrome. The UBM image confirms that the lens is oriented without tilt, and that Z syndrome is not an issue in this patient (Please see Fig. 1). However, when comparing the UBM of the right eye to that of the left, it appears that the Crystalens in the right eye sits more anteriorly than the Tecnis IOL in the left eye. The Crystalens IOL is designed to sit more posteriorly than other IOLs, including the Tecnis. This further suggests that slight anterior displacement of the patient's Crystalens likely contributed to the myopic shift.

Another parameter that might have contributed to this patient's myopic shift is a change in corneal curvature. The average of the preoperative K readings (K1 40.27D @ 134, K2 40.71D @ 44) is SE 40.49D. The average of the postoperative K readings (K1 40.62D @ 175, K2 41.16D @ 85) is SE 40.89D. This would account for 0.4D (40.89D-40.49D) of corneal steepening and subsequent myopia. However, there is variability when taking K readings using the IOL Master. In addition, the preoperative K readings were taken with an IOL Master 500 and the postoperative K readings with an IOL Master 700. This alone might account for some variability in the measurements. Even so, these readings indicate some change in corneal steepness pre and post

Table 1
Pre and post-operative measurements of anterior chamber depth, average corneal curvature, and axial length.

	Pre-Operative	Postoperative	Delta
Anterior Chamber Depth	5.09 mm*	5.08 mm	- 0.01 mm
Avg. Corneal Curvature	40.49 D	40.89 D	+0.40 D
Axial Length	25.40 mm	25.32 mm	- 0.08 mm

*Indicates estimated measurement based on current literature.

vitrectomy. Therefore, the patient's resultant postoperative myopia may have been a result of several factors; a slight anterior micro displacement of the accommodating IOL by the gas bubble, as well as a steepening in corneal curvature due to vitrectomy and gas.

Next, we chose to investigate whether a change in axial length may have contributed to the patient's myopic shift. Typically, a myopic shift would be associated with an increase in axial length. The patient's axial length before any surgeries was 25.40 mm. After retinal repair, the patient's axial length was measured to be 25.32 mm. Interestingly, this equates to a shortening of axial length by 0.08 mm. We would expect this to be representative of a hyperopic change in vision. Therefore, this patient's myopic shift cannot be explained by the change in axial length (Please see Table 1).

It is important to keep the type of IOL implanted in mind, as this may play a role in its displacement during vitrectomy with gas tamponade. The refractive effect of an IOL depends on not only its optic configuration, but also its position within the eye.[2] Additionally, different IOLs have varying hydrophilicity, optic diameter, haptic properties, and angulation, all of which may contribute to movement in the eye following subsequent surgeries.[11] Currently, to the authors' knowledge, there are minimal studies researching how accommodating IOLs, such as Crystalens, may contribute to refractive changes following subsequent surgeries. There seem to be no studies comparing accommodating IOLs to monofocal IOLs in regard to myopic shift following vitrectomy with gas tamponade.

Further research is needed to understand the mechanism of myopic shift following vitrectomy and vitrectomy with gas tamponade. We plan a prospective study of corneal curvature and anterior chamber depth in patients undergoing vitrectomy and gas tamponade.

4. Conclusion

We present a case of a postoperative cataract patient who experienced a myopic shift following vitrectomy and gas tamponade. It was our initial hypothesis that the gas displaced the Crystalens anteriorly, causing a myopic shift. Using current literature, we estimated the patient's post-cataract surgery ACD to be 5.09 mm.[2] Based on the patient's post-operative A-scan, this correlates to just a 0.01 mm anterior movement following gas tamponade. This estimated change in ACD does not account for the −1.0 D myopic shift. We cannot say with certainty that anterior movement of this patient's Crystalens did not play a role in his myopic shift; however the fact that his refraction was plano before retinal detachment likely indicated the IOL was in the typical position.

We also compared pre and postoperative K values and showed that change in corneal steepness might have contributed to the change in refraction. Therefore, the resultant postoperative myopia was likely a result of several factors; a slight anterior micro-displacement of the accommodating IOL by the gas bubble, as well as a steepening in corneal curvature. Further study is needed to fully elucidate the mechanism causing the myopic shift seen in many patients post vitrectomy, as well as whether a patient with a previously implanted accommodating IOL is at greater risk for myopic shift following vitrectomy. Future study should compare pre- and post-vitrectomy measurements in a cohort of patients that had previous cataract surgery.

A pertinent question remains: would knowing the mechanism behind this patient's myopic shift have changed the management of this patient? Given the ultimate excellent outcome in this patient in the face of a series of complex eye procedures, it would be difficult to suggest that an alternate approach would have led to a better outcome. Our purpose in presenting this case is to add to the current literature regarding myopic shifts in similar patients. Perhaps with further elucidation of the exact mechanism behind these myopic shifts, surgical techniques might be altered to ensure a more desirable outcome.

Patient consent statement

Patient consent to publish this case report was not obtained. This report does not contain any information that could lead to identification of the patient and is HIPAA compliant.

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Conflicts of interest

The authors have no relevant financial disclosures.

Authorship

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

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