Corneal edema and penetrating keratoplasty after anterior chamber phakic intraocular lens implantation

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Phakic intraocular lens (IOL) implantation is an increasingly popular option in surgical correction of refractive error. To date, reports of long-term morbidity are infrequent in the literature. We encountered 3 patients who experienced corneal decompensation and cataract progression following angle-fixed anterior chamber phakic IOL placement.

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Surgical approaches to correct refractive errors have expanded in recent years to include implantation of a phakic intraocular lens (IOL) in the anterior or posterior chamber. Three IOL types are currently available: the angle-fixed anterior chamber IOL (AC IOL), iris-fixed AC IOL, and posterior chamber IOL (PC IOL). With this surgical approach, an IOL is implanted in an eye in which the crystalline lens is left intact.

The potential benefits of the phakic IOL are many. Fechner and coauthors found short-term morbidity and excellent visual outcomes with phakic IOLs. Because the crystalline lens is still present, accommodation is maintained. This approach also offers advantages over keratorefractive surgery, including maintenance of corneal asphericity and less reduction in contrast sensitivity.

Despite the potential benefits and advantages of this approach, it is not without potential adverse consequences. We present 3 patients with angle-supported AC IOLs who had progressive loss of vision from corneal edema and cataract formation.

Case 1

A 71-year-old man was referred to the General Eye Clinic at the Institute of Ophthalmology and Visual Science, New Jersey Medical School, for subacute loss of vision in the left eye. The patient had a history of phakic AC IOL implantation in both eyes for correction of hyperopia 2 years before presentation. One year after implantation, the IOL was removed from the left eye. On presentation, the patient's best corrected visual acuity (BCVA) in the right eye was 20/25 and uncorrected visual acuity (UCVA) was 20/400 (20/100 with a pinhole) in the left eye. Slitlamp examination was significant for anterior chamber inflammation and trace nuclear cataract in the right eye (Figure 1). An edematous cornea with stromal scar was observed in the left eye (Figure 2). The anterior chamber in the left eye had a retained haptic at the 6 o'clock position. Visually significant nuclear sclerotic cataract was also noted in the left eye. The fundus examination was within normal limits in both eyes. The patient then had removal of the retained AC IOL haptic, cataract extraction, PC IOL insertion, and penetrating keratoplasty (PKP) in the left eye. The patient did well postoperatively, achieving a final BCVA of 20/25 in the left eye.

Over the next year, visual acuity in the right eye progressively declined from 20/25 to counting fingers. At this time, intraocular
pressure (IOP) was normal bilaterally. Slitlamp examination of the right eye revealed corneal edema, bullae formation, and nuclear sclerosis. The left eye had a clear corneal graft and a PC IOL in place. The patient had AC IOL removal, extracapsular cataract extraction (ECCE), PC IOL implantation, and PKP in the right eye. Postoperative course was uneventful. At last examination, the BCVA had recovered to 20/40 in the right eye and 20/25 in the left eye.

**Case 2**

A 69-year-old man presented to the Cornea and Laser Eye Institute after having a phakic AC IOL implanted 3 years previously in the right eye and 5 years previously in the left eye for correction of hyperopia. One month before presentation, the left IOL was repositioned. At the time of presentation, BCVA in the right eye was 20/25 with $-1.50 \times 94$ and the UCVA in the left eye was 20/200, 20/70 with pinhole. Slitlamp examination revealed oval pupils and an AC IOL bilaterally and corneal edema with mild endothelial folds in the left eye. Nuclear sclerosis was also noted in both eyes. The mean corneal pachymetry, measured using a Corneo-Gage Plus pachymeter (Sonogage) was 0.56 mm and 0.62 mm, respectively. The IOP was 20 mm Hg and 18 mm Hg, respectively. Conservative and surgical management was discussed with the patient, and surgical correction was postponed.

Two months later, the patient’s acuity was unchanged in the right eye and remained at 20/200 in the left eye. Corneal thickness had increased to 1.60 mm in the left eye. At this time, the decision was made to perform AC IOL removal, ECCE, PC IOL implantation, and PKP. Intraoperatively, an expulsive choroidal hemorrhage occurred. After this, the patient had PKP followed by 2 vitreoretinal surgeries. At last follow-up, BCVA was 20/25 in the right eye and hand motions in the left eye.

**Case 3**

An 83-year-old woman presented to the Cornea and Laser Eye Institute complaining of deteriorating vision in the right eye. In 1994, the patient had cataract extraction with PC IOL insertion in the left eye. She had a history of phakic AC IOL placement in the right eye in 1995 for hyperopia. The patient subsequently developed a cataract in the right eye and had IOL explantation, cataract extraction, and PC IOL implantation 7 years later. Vision in the right eye deteriorated following this procedure, prompting her visit to the institute. The BCVA at presentation was 20/400 in the right eye and 20/25 in the left eye. The IOP was 14 mm Hg bilaterally. Slitlamp examination was significant for corneal stromal edema, epithelial bullae formation, and a well-positioned PC IOL in the right eye. The left eye had a clear cornea and well-positioned PC IOL. A recommendation of PKP in the right eye was given. In May 2003, the patient required chemotherapy for a gastric lymphoma, and it was decided PKP was not appropriate. The patient was subsequently scheduled for PKP in July 2004, but she cancelled the surgery. At the last examination, BCVA was counting fingers in the right eye and 20/25 in the left eye.

**DISCUSSION**

The mean age of the patients (4 eyes) was 74.3 years (range 69 to 83 years). Preoperative BCVA in the eyes in which the complications occurred ranged from 20/200 to counting fingers. The time to the complications following initial phakic IOL insertion ranged from 2 to 8 years. Three eyes had combined procedures consisting of IOL removal, cataract extraction, PC IOL insertion, and PKP. The fourth
eye did not have these procedures at the discretion of the patient. The BCVA in this eye deteriorated from 20/400 to counting fingers. Of the 3 eyes that received combined procedures, 2 achieved good BCVA (20/40 and 20/25). The fourth eye had an expulsive choroidal hemorrhage, and BCVA was hand motion at the last visit.

Although phakic IOL implantation can be an effective approach for correcting refractive error, severe complications can occur. Serious events such as endophthalmitis following angle-supported AC IOL implantation and pupillary block following angle-supported AC IOL implantation have been reported. Ruiz-Moreno and coauthors report a 4.8% incidence of retinal detachment following angle-supported AC IOL implantation. Other less acute complications of angle-supported AC IOLs include postoperative elevated IOP, postoperative uveitis, halos, pupil ovalization, and IOL rotation.

Endothelial cell loss following phakic IOL implantation has been well established. Ravalico and co-authors compared the mean endothelial cell density (ECD) in patients who had implantation of an AC IOL in 1 eye and were phakic or pseudophakic with a PC IOL in the other eye. The eyes with an AC IOL had a significantly lower ECD than the unoperated phakic eyes.

Mechanical trauma to the endothelium at the time of surgery is believed to be a major cause of endothelial cell loss. In addition, chronic endothelial damage could be a consequence of intermittent contact between the cornea and the IOL. Natural age-related endothelial cell loss has also been reported, and its rate is estimated to be 0.6% per year.

In our patients, corneal decompensation with bullous keratopathy necessitated corneal transplantation. Although endothelial cell loss after phakic IOL insertion has been reported, frank corneal edema has not. Bullous keratopathy is a known complication of AC IOL insertion and has been attributed to contact between the IOL haptic and the anterior chamber angle and intermittent or constant touch between the IOL and the corneal endothelium. All our patients had phakic IOL insertion for correction of hyperopia, and it has been shown that hyperopic eyes have a more shallow anterior chamber depth than myopic or emmetropic eyes. It can be speculated that the eyes of these patients had relatively shallow anterior chambers and that there was IOL contact with the corneal endothelium and the angle. Hence, it is possible that the surgical insertion of the phakic AC IOL, natural decline in endothelial cell count in these older patients, and IOL–cornea and IOL–angle contact caused a cell count below what was needed for corneal dehydration, thus causing corneal edema and bullous keratopathy.

Although cataract formation with the use of phakic PC IOLs has been well documented, it has also been reported with the use of AC IOLs. Alió and coauthors studied a group of patients who developed cataract following angle-supported phakic AC IOL implantation; all cases were nuclear cataracts. The authors determined that high myopia and age greater than 40 years were the major factors in cataract formation in these patients. Close approximation of the phakic IOL to the crystalline lens is also purported to be involved in cataractogenesis.

Given the advanced age of our patients, it is likely that they had some nuclear sclerosis before surgery. It is also likely that having the phakic IOL in such close proximity to the natural lens contributed to more rapid cataract formation in these patients. Treatment for cataract formation secondary to phakic IOLs has been satisfactory with IOL removal, ECCE, and PC IOL implantation.

Although no patient in our study was able to provide information regarding the type of phakic IOLs implanted, slitlamp and intraoperative examination of the IOL and historical investigation indicated that they were an early version of the Phakic 6 (Ophthalmic Innovations International) in all cases. This angle-supported AC IOL is not necessarily representative of the newer generation IOLs. It has thicker edges than other angle-supported AC IOLs. The thicker edge might have led to IOL contact with the corneal endothelium and the anterior chamber angle. In our patients who were hyperopic and likely had shallow anterior chambers, this type of contact could have predisposed them to the development of corneal decompensation and bullous keratopathy.

The first angle-supported AC IOL was the ZB lens (Bausch & Lomb), which had an optic diameter of 4.5 mm. Significant endothelial cell loss, believed to be caused by the peripheral edge thickness of the IOL optic, was seen. In the next model, the ZBSM, the diameter of the optic was enlarged to 5.0 mm and the periphery of the lens was adjusted. Ovalization of the pupil, leading to iris atrophy in some cases, was the main complication.

The NuVita MA 20 IOL (Bausch & Lomb Surgical) is the latest generation of the phakic angle-supported AC IOLs. Its effective optic diameter was increased from 4.0 to 4.5 mm, and the haptic was modified to reduce peripheral contact of the IOL on the iris. Allemann et al. followed patients who received this phakic IOL for 2 years and found good visual results. Pupil ovalization, endothelial cell loss, halos and glare, and IOL rotation were the major complications. Foldable IOLs, which include a totally flexible lens (Kelman) and a lens with rigid haptics supporting a flexible optic (Baikoff), have also been proposed.

Despite new phakic IOL designs, the cases we report suggest that phakic IOLs may not be without morbidity. As seen here, cataract and corneal decompensation are possible late postoperative problems with the use of the angle-supported phakic AC IOLs. Surgical correction consisting of phakic IOL removal, cataract extraction, PC IOL
insertion, and PKP can be performed for visual rehabilitation in patients with these complications. However, the surgical treatment carries the potential risk for visually significant complications.

REFERENCES