Results of cataract surgery after implantation of an iris-fixated phakic intraocular lens

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PURPOSE: To report the results of cataract surgery after previous implantation of an Artisan iris-fixated phakic intraocular lens (pIOL) for the correction of myopia.

SETTING: University center and private practice.

METHODS: This study comprised eyes with previous implantation of an iris-fixated pIOL to correct myopia and subsequent pIOL explantation combined with cataract surgery and in-the-bag implantation of a posterior chamber IOL. Predictability of refractive results, changes in endothelial cell density (ECD), and postoperative best corrected visual acuity (BCVA) were analyzed.

RESULTS: The mean follow-up after cataract surgery in the 36 eyes of 27 consecutive patients was 5.7 months ± 7.5 (SD). The mean time between pIOL implantation and cataract surgery was 5.0 ± 3.4 years. After explantation of the pIOL and subsequent cataract surgery, the mean spherical equivalent (SE) was −0.28 ± 1.11 diopters (D); the SE was within ±1.00 D of the intended correction in 72.2% of patients and within ±2.00 D in 86.1% of patients. The mean endothelial cell loss after the combined procedure was 3.5% ± 13.2% and the mean postoperative BCVA, 0.17 ± 0.18 logMAR.

CONCLUSIONS: In patients with a history of implantation of an iris-claw pIOL for the correction of myopia, cataract surgery combined with explantation of the pIOL yielded acceptable predictability of the postoperative SE and minimal loss of ECD, resulting in a gain in BCVA.

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The Artisan (Ophtec) is an iris-fixated poly(methyl methacrylate) (PMMA) anterior chamber intraocular lens (IOL) that can be used for the correction of ametropia in aphakic and phakic eyes. It has been proved to be an effective and safe option for the treatment of naturally occurring myopia, hyperopia, and astigmatism in phakic eyes.[1–9] Furthermore, it has been used for the correction of ametropia in eyes with pellucid marginal degeneration[10] or keratoconus,[11] after perforating keratoplasty,[12,13] after radial keratotomy[14] for the correction of aphakia following uneventful cataract surgery when capsule support has been lost,[15] and in cataract surgery for traumatic cataract in children.[16] Long-term follow-up studies found the IOL to be safe in terms of the potential risk for induction of cataract and endothelial cell loss.[1–3,17,18] However, when applied in phakic eyes, cataract not related to the phakic IOL (pIOL) may develop (Figure 1).

In this paper, we describe the technique and the results of explantation of iris-claw pIOLs followed by cataract surgery and implantation of a posterior chamber IOL. Potential risks of the procedure are high endothelial cell loss resulting from manipulation of the pIOL and subsequent phacoemulsification, intraoperative and postoperative complications, low predictability of the final refraction because of high levels of surgically induced astigmatism (SIA) secondary to removal of the rigid IOL through a large limbal incision, faulty axial length (AL) measurements in the

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Dr. Budo is a consultant to Ophtec. No author has a financial or proprietary interest in any material or method mentioned.

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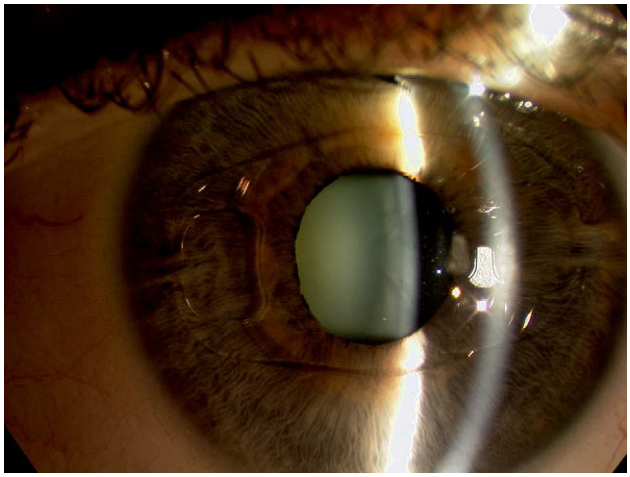

Figure 1. Cataract in a 50-year-old woman 5 years after implantation of a −11.0 D iris-fixated Artisan pIOL.

presence of an anterior chamber IOL, and inappropriate results from the formula used for IOL power calculation.

PATIENTS AND METHODS

This study comprised eyes with a history of implantation of a rigid PMMA pIOL (Artisan) for the correction of myopia. Before IOL implantation, patients were informed of the possible occurrence of cataract that would necessitate cataract surgery in the future. The tenets of the Declaration of Helsinki were followed.

Implantation of the pIOL was performed by 1 of 2 experienced surgeons (C.B., R.N.) in 26 cases. One patient had pIOL implantation at a referring hospital.

Axial length and anterior segment size were measured before pIOL explantation and subsequent cataract surgery using interferometry (IOLMaster, Carl Zeiss Meditec AG) or A-scan ultrasonography. The SRK/T formula was used for IOL power calculation, and the targeted refraction was emmetropia.

All cataract surgery was performed by 1 of 2 surgeons (C.B., R.N.) between 1999 and 2007. The cataract surgery procedure consisted of explantation of the pIOL followed by phacoemulsification, irrigation/aspiration (I/A), and in-the-bag implantation of an IOL in a combined procedure. In some eyes, phacoemulsification was performed via the limbal incision that had been used for removal of the pIOL; this was followed by partial closure of the incision with 10-0 nylon sutures. In the other eyes, a separate incision was used for both steps. Bimanual I/A was performed via the 2 clear-corneal side ports that had been used for deenclavation of the iris-fixated haptics. One of the following posterior chamber IOLs was implanted after cataract surgery: AcrySof MA60AC, MA60BM, MA60MA, MN60MA, MA30BA, SA30AL, SA60AT, SN60AT, or SN60WF foldable hydrophobic acrylic (Alcon Laboratories) or PS60ANB (Advanced Medical Optics), Duralens 60L (Advanced Medical Optics), or MZ60MD (Alcon Laboratories) rigid PMMA.

The patient age at the time of pIOL implantation, the time between pIOL implantation and subsequent cataract surgery, the method used for IOL power calculation, the predictability of the refractive results, the type and power of the posterior IOL implanted, changes in endothelial cell density (ECD), complications during cataract surgery, postoperative best corrected visual acuity (BCVA), and SIA were analyzed. Visual acuity was determined using Snellen charts, and logMAR values were used for calculations.

Before cataract surgery, patients had a full ophthalmologic examination including manifest refraction, keratometry, slitlamp biomicroscopy, Goldmann applanation tonometry, and binocular indirect ophthalmoscopy through a dilated pupil. Endothelial cell density was measured with a noncontact specular microscope (Noncon Robo SP 8000, Konan Medical). The power of the posterior chamber IOL to be implanted was calculated using the SRK/T formula. Axial length was measured in the presence of the pIOL by ultrasound or interferometry (IOLMaster).

Data analysis was performed using SPSS for Windows (version 14.0, SPSS Inc.).

RESULTS

Thirty-six eyes of 27 patients were included in the study. Table 1 shows the preoperative data. The mean AL was determined by ultrasound in 19 eyes and by interferometry in 17 eyes. Two eyes (5.6%) had surgery for retinal detachment (RD) before the

Table 1. Preoperative data.

Parameter	Minimum	Maximum	Mean	SD
IOL-related data				
BCVA (logMAR) before IOL implantation	0.00	0.70	0.21	0.21
Age (y) at IOL implantation	35.3	68.2	49.9	8.1
Cataract surgery–related data				
BCVA before cataract surgery	−0.08	2.00	0.45	0.38
Age (y) at cataract surgery	41.1	71.3	54.9	8.6
Time between IOL implantation and cataract surgery (y)	0.5	13.4	5.0	3.5
Axial length (mm)	22.83	34.28	29.30	2.51
Endothelial cell density (cells/mm^2)	650	3500	2355	701

BCVA = best corrected visual acuity; IOL = intraocular lens

cataract surgery; 1 eye had RD surgery 1 year after pIOL implantation and the other, 10 years before pIOL implantation. One eye (2.8%) had been treated successfully for endophthalmitis after pIOL implantation. Eight eyes (22.2%) had significant myopic degeneration of the posterior pole; in 5 of these eyes, the BCVA had been limited due to myopic degeneration before implantation of the pIOL. One eye (2.8%) was treated for open-angle glaucoma. Slitlamp examination before cataract surgery showed pigment deposits on the pIOL and synechias in 3 eyes (8.3%).

Table 2 shows the data after pIOL explantation, cataract surgery, and in-the-bag posterior chamber IOL implantation. In 30 of the 36 cases, phacoemulsification was performed via the limbal incision that had been used for removal of the pIOL; in the other 6 eyes, a separate incision was used for both steps. Of the 36 posterior chamber IOLs implanted in the capsular bag, 5 were PMMA (2 PS60ANB, 2 Duralens 60L, 1 MZ60PD) and 31 were hydrophobic acrylic (10 MA60MA, 1 MN60MA, 1 MA60BM, 1 MA60AC, 1 MA30BA, 4 SA60AT, 1 SA30AL, 9 SN60AT, and 3 SN60WF). During the procedure, no vitreous loss or capsule rupture occurred in any eye. No eye had an RD during the follow-up period.

After cataract surgery, the spherical equivalent (SE) was within ±1.00 D of the intended correction in 72.2% of patients and within ±2.00 D in 86.1% of patients. The mean postoperative SE was −0.07 D ± 1.10 (SD) in eyes in which the AL had been determined using ultrasound and −0.51 ± 1.11 D in eyes in which the AL had been determined using interferometry ($P = .240$). The mean postoperative SE was within ±1.00 D of the intended correction in 73.7% of eyes in the ultrasound group and 70.6% of eyes in the interferometry group ($P = .836$) and within ±2.00 D of the intended correction in 84.2% of eyes and 88.2% of eyes, respectively ($P = .727$).

Thirty eyes (83.3%) had a BCVA of 20/40 or better after cataract surgery

Table 2. Data after cataract surgery.

Parameter	Minimum	Maximum	Mean	SD
Follow-up (mo)	0.2	31.5	5.7	7.5
Implanted IOL power (D)	−7.0	19.0	5.5	6.2
Spherical equivalent (D)	−2.75	2.13	−0.28	1.11
BCVA (logMAR)	−0.18	0.60	0.17	0.18
Topographical astigmatism (D)	0.25	4.87	1.31	0.87
Surgically induced astigmatism (D)	0.17	3.01	0.96	0.77
Endothelial cell density (cells/mm^2)	636	3394	2207	703
Endothelial cell change (%)	−31.0	25.0	3.5	13.2

BCVA = best-corrected visual acuity; IOL = intraocular lens

DISCUSSION

Posterior chamber pIOLs and angle-supported anterior chamber pIOLs can lead to cataract formation in a considerable percentage of patients,[19–21] necessitating a combined procedure of pIOL explantation and cataract surgery.[22,23] The anterior chamber iris-fixated Artisan pIOL, however, has been shown to be safe with regard to inducing cataract in studies with a follow-up of up to 10 years.[3,5,18] Implantation of an Artisan pIOL can lead to cataract if performed traumatically, which was not the case in our patients. It can also lead to cataract if the inclusion criteria regarding anterior chamber depth (ACD) and the distance between the posterior surface of the pIOL and the anterior surface of the crystalline lens is not respected. However, we do not believe this was the case in our study except for the patient who was referred from elsewhere (Figures 2 and 3), whose ACDs were within the limits of the inclusion criteria (≥3.0 mm). Still, especially in older and often highly myopic patients with an Artisan pIOL, cataract formation unrelated to the IOL (Figures 1 and 4) will eventually arise, leading to glare complaints and loss of visual acuity. In addition, in some cases, an increase in lens rise results in shallowing of the anterior chamber, formation of posterior synechias, and pigment deposition on the anterior lens capsule, which can necessitate explantation of the pIOL and cataract surgery (Figures 2 and 3).

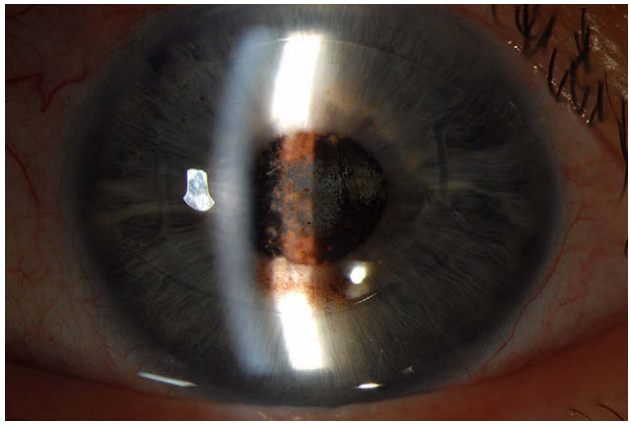

Figure 2. Cataract, pigment deposition, and posterior synechias in a 49-year-old woman following implantation of an Artisan pIOL for high myopia. The initial pIOL implantation was performed elsewhere.

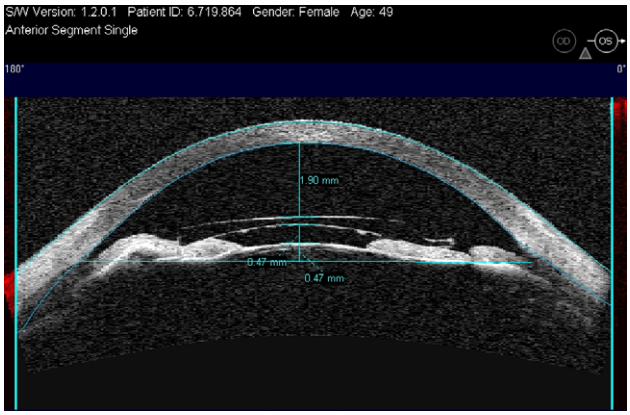

Figure 3. Optical coherence tomography image of the eye in Figure 2 shows shallowing of the anterior chamber (1.90 mm) and increased lens rise (0.47 mm) in the presence of cataract.

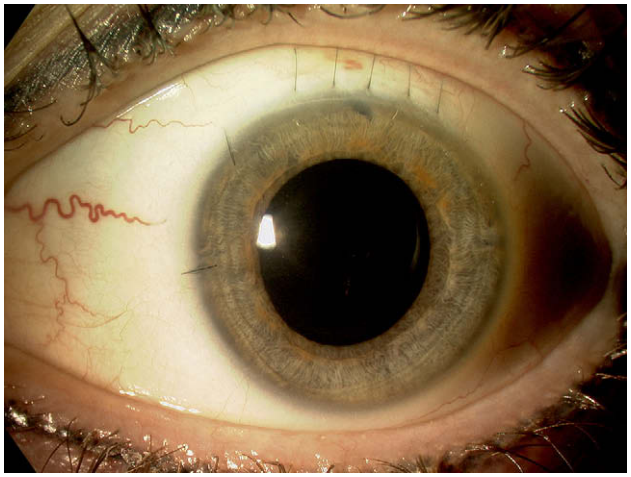

Figure 4. Slitlamp photography after cataract surgery in the eye in Figure 1.

The aim of the current study was to describe the safety and predictability of a combined procedure of explantation of the Artisan pIOL and subsequent cataract surgery.

Similar to cataract surgery in patients with previous laser in situ keratomileusis, an important consideration in this patient group is the predictability of the postoperative refractive result. To our knowledge, only 1 study has described a procedure for combined explantation of anterior chamber pIOLs followed by cataract surgery.[24] That study consisted of a group with both anterior pIOLs and posterior pIOLs and a large number of patients (6 of 19 eyes) who had previous corneal refractive procedures. The IOL power to be implanted was calculated in the study using an algebraic formula as well as the results of intraoperative autorefraction after phacoemulsification and reformation of the anterior chamber. In the current study, we present the results of a larger (36 eyes) and more uniform (all iris-fixated anterior chamber pIOLs, none with previous corneal refractive procedures) group of patients having cataract surgery after previous implantation of an anterior chamber pIOL. Calculation of the IOL power was performed in a less complex way using a standard SRK/T formula, and preoperative AL and keratometry measurements were performed using interferometry or ultrasound. Our results show that both measurement techniques yield acceptable predictability of postoperative refractive results. The mean SE was -0.28 ± 1.11 D; the SE was within ± 1.00 D and ± 2.00 D of the intended correction in 72.2% and 86.1% of patients, respectively. There was no statistically significant difference in mean postoperative SE between eyes in which the AL had been determined using ultrasound (mean SE -0.07 ± 1.10 D) and in eyes in which the AL had been determined using interferometry (mean SE -0.51 ± 1.11 D) ($P = .240$). The postoperative SE was within ± 1.00 D in 73.7% of eyes in the ultrasound group and 70.6% in the interferometry group ($P = .836$) and within ± 2.00 D in 84.2% and 88.2%, respectively ($P = .727$).

The safety of cataract surgery combined with explantation of the pIOL depends on endothelial cell loss, occurrence of complications, and whether there is loss of the BCVA. Several studies have shown little change in ECD after implantation of the Artisan pIOL[3–5,17,25] as well as a correlation between endothelial cell loss and ACD,[7] showing the importance of an adequate (>3.0 mm) ACD. Explantation of a rigid pIOL from the anterior chamber followed by cataract surgery, however, could carry a risk for endothelial cell loss. In our study, that mean endothelial cell loss of the combined procedure was $3.5\% \pm 13.2\%$. The gain in ECD in some patients might have been the result of the limited reproducibility of ECD measurements, which is reported to be only 7%.[26] Another explanation could be the redistribution of peripheral endothelial cells toward the central cornea, the area where the ECD measurements take place.[27] Despite questions about the reliability of specular microscope measurements,[28] these changes in ECD indicate that the procedure in general can likely be performed without severe endothelial loss. Preoperative ECD after Artisan pIOL implantation varied widely in our study (650 to 3500 cells/mm^2). Three eyes had an ECD less than 1000 cells/mm^2 before cataract surgery. In 1 eye, retinal detachment surgery had been performed; in the other 2 eyes of a 72-year-old patient, the interval between pIOL implantation and cataract surgery was 13.4 years. No corneal decompensation occurred, even in the

patient with the lowest ECD before cataract surgery. No other potential complication (eg, postoperative retinal detachment, capsule rupture, vitreous) occurred.

High levels of SIA could potentially result from this procedure. The surgical technique described below (ie, using a corneoscleral incision for pIOL explantation and a temporal incision for phacoemulsification) was introduced to minimize SIA. In the current study group, the resulting SIA was 0.96 ± 0.77 D. No patient lost lines of BCVA. The relatively low mean postoperative BCVA (0.17 ± 0.18 logMAR) can be explained by the relatively large number of patients with preexisting pathology such as previous retinal detachment (2 patients) and extensive myopic degeneration of the posterior pole (8 patients), including 1 retinal staphyloma.

We now use separate incisions for the removal of the Artisan pIOL and the phacoemulsification procedure. The pIOL is removed through a superior corneoscleral incision and the phacoemulsification procedure is performed through a temporal clear corneal incision. Bimanual I/A is subsequently performed via the two 1.2 mm clear corneal side ports that were prepared for deenclavation of the iris-fixated haptics. In addition, a biaxial technique could be used for performing the phacoemulsification through the 1.2 mm clear corneal side ports. At the end of the procedure, the corneoscleral incision is partly opened for implantation of the IOL. Figure 4 shows a postoperative photograph in an eye after the described procedure. Using this 2-stage technique, the surgery can be performed with well-controlled anterior chamber stability, enhancing the safety of the procedure.

In conclusion, the results in this series of 36 eyes show that cataract surgery in patients with previous implantation of an iris-fixated Artisan pIOL for myopia is safe with regards to endothelial cell loss, occurrence of complications, and loss of BCVA. In addition, the level of predictability was acceptable in this group of patients with high myopia using standard SRK/T calculations based on standard preoperative measurements with interferometry or A-scan ultrasound.

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