Implantation of a toric phakic intraocular lens to correct high corneal astigmatism in a patient with bilateral marginal corneal degeneration

Marjolijn C. Bartels, MD, Gabriel van Rij, MD, Gregorius P.M. Luyten, MD

We present a patient with marginal corneal degeneration and corneal astigmatism of more than 10.0 diopters (D). A toric phakic intraocular lens (IOL) of 7.0 D cylindrical power was implanted in both eyes to correct the high astigmatism. An uncorrected visual acuity of 20/40 was achieved in both eyes, and the best corrected visual acuity improved by 4 Snellen lines to 20/20 in both eyes. Refraction and visual acuity remained stable at 1.5 years postoperatively. Implantation of a toric phakic IOL can be an option to correct high corneal astigmatism even when the full corneal astigmatism cannot be treated.

J Cataract Refract Surg 2004; 30:499–502 © 2004 ASCRS and ESCRS

Peripheral marginal degeneration of the cornea can lead to severe visual loss secondary to excessive astigmatism. Various techniques can be used to treat astigmatism. In the early stages, mild to moderate astigmatism can be corrected with spectacles and contact lenses. If marginal degeneration progresses to thinning of the peripheral cornea and results in severe astigmatism and contact lens intolerance, alternative methods are necessary.

Several surgical procedures have been used to treat astigmatism (eg, crescentic lamellar keratoplasty and excision of ectatic stroma), but the ideal treatment has not been found.[1,2] Laser in situ keratomileusis (LASIK) is acceptable for the correction of mild to moderate astigmatism[3] but is not appropriate in cases with high irregular astigmatism such as marginal degeneration, keratoconus, and astigmatism that occurs after penetrating keratoplasty (PKP). These patients could benefit from phakic toric intraocular lenses (IOLs)[4] such as the Artisan phakic IOL, which is shown to correct high myopia with a stable and fairly predictable refractive outcome.[5,6] Artisan toric phakic IOLs are available with a cylindrical power up to 7.0 diopters (D) and are appropriate for treatment of high astigmatism.[7]

Case Report

A 51-year-old man with peripheral marginal corneal degeneration was referred to us in 1996 with a best corrected visual acuity (BCVA) of 20/100. An examination in 1991 revealed a BCVA of 20/20 in both eyes with a refraction of $-6.00\ -5.00 \times 87$ in the right eye and $-8.50\ -5.00 \times 115$ in the left eye. Ocular history included a peripheral laser coagulation treatment in the left eye in 1988 for an asymptomatic peripheral retinal hole. The patient's high astigmatism resulted from bilateral marginal corneal degeneration present in the inferior cornea with some vascularization, consistent with the diagnosis of Terrien marginal degeneration. The medical history was unremarkable, and the patient did not have a collagen or vascular disease or an atopic constitution.

Because of the patient's low visual acuity with spectacle correction at the time of presentation, the use of contact lenses to correct myopia and astigmatism was advised. With contact lenses, the visual acuity was 20/20 in the right eye and 20/30 in the left eye. Four years later, the patient experienced a further decrease in visual acuity despite contact lens correction to 20/50 in both eyes. He was unable to wear contact lenses for more then 2 hours a day.

Accepted for publication June 25, 2003.

From the Department of Ophthalmology, Erasmus Medical Center, Rotterdam, The Netherlands.

None of the authors has a financial or proprietary interest in any material or method mentioned.

Reprint requests to M.C. Bartels, MD, Department of Ophthalmology, Erasmus Medical Center Rotterdam, PO Box 2040, 3000 CA Rotterdam, The Netherlands. E-mail: m.bartels@erasmusmc.nl.

0886-3350/04/$–see front matter
doi:10.1016/j.jcrs.2003.06.005

Because of contact lens intolerance and inadequate visual acuity with spectacles, an alternative method to correct the high myopia and astigmatism was considered. Laser in situ keratomileusis was not a treatment option because of the high astigmatism and extreme thinning of the cornea from marginal degeneration. Implantation of the Artisan phakic IOL was discussed with the patient because of our long experience with this IOL and our 1-year experience with the Artisan toric phakic IOL.

The preoperative BCVA was 20/40 with -4.50 -10.75×81 in the right eye and 20/50 with -3.00 -13.00×115 in the left eye. Keratometry was 41.00/51.00 × 95 and 40.25/52.50 × 100, respectively. The endothelial cell count was 2244 cells/mm^2 in the right eye and 1756 cells/mm^2 in the left eye with a Topcon 2000 specular microscope. Both eyes had a 3.20 mm pupil in daylight that expanded to less than 5.50 mm in dark conditions. A-scan ultrasound showed axial lengths of 26.62 mm in the right eye and 26.40 mm in the left eye with anterior chamber depths of 4.02 mm and 3.91 mm, respectively. Based on the refractive data and limited by the 7.00 D maximum cylinder of the toric IOL, the appropriate toric IOL power was calculated with the Van der Heijde formula to be -5.50 -7.00×90 in the right eye with implantation in axis 171 and -4.00 -7.00×90 in the left eye with implantation in axis 25. The optical zone of these lenses was 5.0 mm.

After the patient was counseled and informed consent was obtained, toric IOL implantation was performed uneventfully in the right eye and 3 weeks later in the left eye. Before surgery and retrobulbar anesthesia, the desired axis location was marked on the sclera with a surgical marker guided by the reflected images of the Javal keratometer on the cornea. Miotic drops (pilocarpine 2%) were administered to prepare the iris for IOL fixation. A limbal beveled incision of 5.5 mm was made at 12 o'clock, and 2 more paracenteses were made at 10 o'clock and 2 o'clock. The anterior chamber was opened and sodium hyaluronate 1.0% (Healon®) was introduced to maintain depth and to protect the endothelium. After implantation, the IOL was fixated to the midperipheral iris stroma with an enclavation needle after it was positioned in the desired axis. At the end of the procedure, a slit iridotomy was performed at 12 o'clock to prevent angle-closure glaucoma and the Healon was manually irrigated. The incision was closed with a 10-0 nylon running suture.

Five days postoperatively, the uncorrected visual acuity (UCVA) in the right eye was 20/40 and the BCVA, 20/25 with $+1.25$ -3.25×102. Further ocular examination was unremarkable and the iris-claw IOL was well centered and stable, so surgery was performed in the left eye. Five days after surgery in the left eye, the UCVA was 20/40 and the BCVA was 20/25 with -3.25 -1.25×73. At 75 days in the right eye and 55 days in the left eye, the refraction remained stable with a UCVA of 20/40 and a BCVA of 20/25 in both eyes. After 6 months, the subjective refraction was -1.75 -0.75×15 in the right eye and -2.50 -0.75×139 in the left eye. At 1.5 years, the subjective refraction remained fairly stable at -1.00 -0.50×70 in the right eye and -3.00 -0.75×125 in the left eye; the BCVA was 20/20 in both eyes (Table 1). The keratometry changed marginally from the preoperative readings (Table 1). The endothelial cell count was 2694 cells/mm^2 in the right eye and 1654 cells/mm^2 in the left eye.

Discussion

Implantation of a toric IOL is an alternative treatment for the correction of high astigmatism. The result we achieved in this case was excellent. Based on the toric IOL's maximal correction of 7.00 D cylindrical power, the residual cylinder achieved in the subjective refraction was much lower than expected. The preoperative subjective refractive cylinder of -10.75×81 in the right eye and -13.00×115 in the left eye changed after toric IOL implantation to -0.50×70 and -0.75×125, respectively, with almost no change in corneal astigmatism, according to keratometry readings. Correction of the cylinders along with correction of the residual myopia led to a BCVA of 20/20 in both eyes.

Annular lamellar keratoplasty (LKP) and corneal wedge excision have been performed in marginal corneal degeneration cases to control corneal astigmatism. Reports of annular LKP are restricted to a few cases; no large series has been reported.[2,8–10] Along with other authors, we found that this procedure is not an optimal treatment. The time required for visual rehabilitation with LKP is longer than with toric IOL implantation. Reports of corneal wedge excision show a poor long-

Table 1. Preoperative and postoperative visual acuity, refraction, and keratometry in both eyes.

	Right Eye			Left Eye		
	BCVA	Subjective Refraction	Keratometry	BCVA	Subjective Refraction	Keratometry
Preoperative	20/40	$-4.50 - 10.75 \times 81$	41.00/51.00 × 95	20/50	$-3.00 - 13.00 \times 115$	40.25/52.50 × 100
5 days postoperative	20/25	$+1.25 - 3.25 \times 102$		20/25	$-3.25 - 1.25 \times 73$	
18 months postoperative	20/20	$-1.00 - 0.50 \times 70$	40.25/52.00 × 90	20/20	$-3.00 - 0.75 \times 125$	39.75/52.5 × 95

term reduction in astigmatism.[1,11,12] Laser in situ keratomileusis has proved to be an effective treatment in eyes with less than 2.0 D of astigmatism,[3] but it cannot adequately correct high astigmatism. In our patient with a thin cornea and high astigmatism, LASIK was not an option. Intraocular refractive surgery was probably the only suitable choice.

Lens extraction with IOL implantation is another option to correct high astigmatism and myopia. There are several case reports and studies of toric IOL implantation after lens extraction.[13–19] Toric IOL implantation after lensectomy results in the loss of accommodation, whereas with the Artisan toric IOL, accommodation is preserved. Rotational instability is a problem with toric IOLs in the capsular bag,[19,20] but rotation of the iris-claw IOL is less likely because of its firm fixation to the midperipheral iris stroma. The off-axis position of an iris-claw lens is caused by incorrect placement of the IOL in the axis during surgery. A greater incidence of postoperative retinal detachment is expected with IOL implantation after lensectomy.[21,22] We consider the phakic toric IOL a more favorable option to correct high astigmatism and myopia in a patient with a clear lens.

Another phakic IOL option is posterior chamber (PC) IOLs. The potential for long-term effects such as cataractogenesis and pigment dispersion with phakic PC IOLs is a serious concern,[23–25] as is endothelial cell loss with phakic iris-claw IOLs.[26] Gimbel and Ziémba[27] report a case with moderate astigmatism of −2.25 in which a toric posterior phakic IOL was used. We chose the Artisan toric anterior chamber IOL because it was the only available toric phakic IOL at the time surgery was planned.

Limitations of the Artisan IOL are a cylindrical power up to only 7.00 D and an optical zone of 5.00 mm. In high myopia, a small optical zone may produce halo effects and glare in dim illumination conditions. Careful patient selection excluding those with a pupil diameter of more than 5.00 mm under scotopic conditions will prevent these side effects. The incidence of astigmatism greater than 7.00 D is low. As this case report illustrates, full correction of astigmatism is not necessary to achieve an excellent BCVA in a patient with marginal corneal degeneration. Possible explanations of this are that the correcting cylinder of the IOL is closer to the nodal point of the eye or that full correction of astigmatism is not necessary because of the extreme irregularity.

The toric Artisan IOL cannot be implanted through a small incision. This can result in induced astigmatism, adding a level of unpredictability to the final result. The induction of astigmatism was negligible compared with the high astigmatism already present in this patient, however, and a change of only 0.5 D in corneal astigmatism with an axis shift of 5 degrees was seen after the procedure. With anterior chamber IOL implantation, there is a possible risk for damage to the endothelium but the endothelial cell loss is probably the result of the surgical procedure.[26,28,29] Extensive follow-up and accurate methods to evaluate mean endothelial cell count are necessary to determine the long-term effect of iris-claw IOLs on endothelial cell loss. In this patient, endothelial cell counts with the Topcon 2000 specular microscope revealed a small decrease in the left eye and a small increase in the right eye. This may reflect the inaccuracy of counting methods.

To our knowledge, there is only 1 report of the implantation of an Artisan toric phakic IOL to correct high astigmatism.[4] This high astigmatism occurred after PKP. We believe our patient is the first in whom high astigmatism from marginal corneal degeneration was corrected with the Artisan toric phakic IOL. Marginal corneal degeneration is usually a contraindication for corneal refractive surgery.[30,31] This patient's visual improvement might not have been achieved through more common methods of refractive surgery.

References

1. Caldwell DR, Insler MS, Boutros G, Hawk T. Primary surgical repair of severe peripheral marginal ectasia in Terrien's marginal degeneration. Am J Ophthalmol 1984; 97:332–336
2. Pettit TH. Corneoscleral freehand lamellar keratoplasty in Terrien's marginal degeneration of the cornea—long-term results. Refract Corneal Surg 1991; 7:28–32
3. Sugar A, Rapuano CJ, Culbertson WW, et al. Laser in situ keratomileusis for myopia and astigmatism: safety and efficacy. (Ophthalmic Technologies Assessment) A report by the American Academy of Ophthalmology. Ophthalmology 2002; 109:175–187
4. Tehrani M, Dick HB. Korrektur eines höhergradigen Astigmatismus nach Keratoplastik durch Implantation einer phaken torischen Iris-Klauen-Linse. Klin Monatsbl Augenheilkd 2002; 219:159–163

5. Budo C, Hessloehl JC, Izak M, et al. Multicenter study of the Artisan phakic intraocular lens. J Cataract Refract Surg 2000; 26:1163–1171
6. Landesz M, van Rij G, Luyten G. Iris-claw phakic intraocular lens for high myopia. J Refract Surg 2001; 17: 634–640
7. Dick HB, Alió J, Bianchetti M, et al. Toric phakic intraocular lens; European multicenter study. Ophthalmology 2003; 110:150–162
8. Schanzlin DJ, Sarno EM, Robin JB. Crescentic lamellar keratoplasty for pellucid marginal degeneration [letter]. Am J Ophthalmol 1983; 96:253–254
9. Kremer I, Sperber LTD, Laibson PR. Pellucid marginal degeneration treated by lamellar and penetrating keratoplasty. Arch Ophthalmol 1993; 111:169–170
10. Hahn TW, Kim JH. Two-step annular tectonic lamellar keratoplasty in severe Terrien's marginal degeneration. Ophthalmic Surg 1993; 24:831–834
11. MacLean H, Robinson LP, Wechsler AW. Long-term results of corneal wedge excision for pellucid marginal degeneration. Eye 1997; 11:613–617
12. Biswas S, Brahman A, Tromans C, Ridgway A. Management of pellucid marginal corneal degeneration. Eye 2000; 14:629–634
13. Gerten G, Michels A, Olmes A. Torische Intraokularlinsen; klinische Ergebnisse und Rotationsstabilität. Ophthalmologe 2001; 98:715–720
14. Frohn A, Dick HB, Thiel H-J. Implantation of a toric poly(methyl methacrylate) intraocular lens to correct high astigmatism. J Cataract Refract Surg 1999; 25:1675–1678
15. Shimizu K, Misawa A, Suzuki Y. Toric intraocular lenses: correcting astigmatism while controlling axis shift. J Cataract Refract Surg 1994; 20:523–526
16. Tehrani M, Schwenn O, Dick HB. Torische Intraokularlinse zur Korrektur eines höhergradigen Astigmatismus nach Keratoplastik bei Pseudophakie—eine Kasuistik. Klin Monatsbl Augenheilkd 2001; 218:795–799
17. Gills JP, Van Der Karr MA. Correcting high astigmatism with piggyback toric intraocular lens implantation. J Cataract Refract Surg 2002; 28:547–549
18. Ruhswurm I, Scholz U, Zehetmayer M, et al. Astigmatism correction with a foldable toric intraocular lens in cataract patients. J Cataract Refract Surg 2000; 26: 1022–1027
19. Sun X-Y, Vicary D, Montgomery P, Griffiths M. Toric intraocular lenses for correcting astigmatism in 130 eyes. Ophthalmology 2000; 107:1776–1781; discussion by RM Kershner, 1781–1782
20. Till JS, Yoder PR Jr, Wilcox TK, Spielman JL. Toric intraocular lens implantation: 100 consecutive cases. J Cataract Refract Surg 2002; 28:295–301
21. Colin J, Robinet A. Clear lensectomy and implantation of low-power posterior chamber intraocular lens for the correction of high myopia. Ophthalmology 1994; 101: 107–112
22. Colin J, Robinet A, Cochener B. Clear lensectomy and implantation of low-power posterior chamber intraocular lens for the correction of high myopia: a four-year follow-up. Ophthalmology 1997; 104:73–77; discussion by RC Drews, 77–78
23. Arne JL, Lesueur LC. Phakic posterior chamber lenses for high myopia: functional and anatomical outcomes. J Cataract Refract Surg 2000; 26:369–374
24. Brandt JD, Mockovak ME, Chayet A. Pigmentary dispersion syndrome induced by a posterior chamber phakic refractive lens. Am J Ophthalmol 2001; 131:260–263
25. Fink AM, Gore C, Rosen E. Cataract development after implantation of the Staar Collamer posterior chamber phakic lens. J Cataract Refract Surg 1999; 25:278–282
26. Menezo JL, Cisneros AL, Rodriguez-Salvador V. Endothelial study of iris-claw phakic lens: four year follow-up. J Cataract Refract Surg 1998; 24:1039–1049
27. Gimbel HV, Ziémba SL. Management of myopic astigmatism with phakic intraocular lens implantation. J Cataract Refract Surg 2002; 28:883–886
28. Landesz M, Worst JGF, Siertsema JV, van Rij G. Correction of high myopia with the Worst myopia claw intraocular lens. J Refract Surg 1995; 11:16–25
29. Menezo JL, Cisneros AL, Cervera M, Harto M. Iris claw phakic lens—intermediate and long-term corneal endothelial changes. Eur J Implant Refract Surg 1994; 6:195–199
30. Hori-Komai Y, Toda I, Asano-Kato N, Tsubota K. Reasons for not performing refractive surgery. J Cataract Refract Surg 2002; 28:795–797
31. Ambrósio R Jr, Wilson SE. Early pellucid marginal corneal degeneration; case report on two refractive surgery candidates. Cornea 2002; 21:114–117