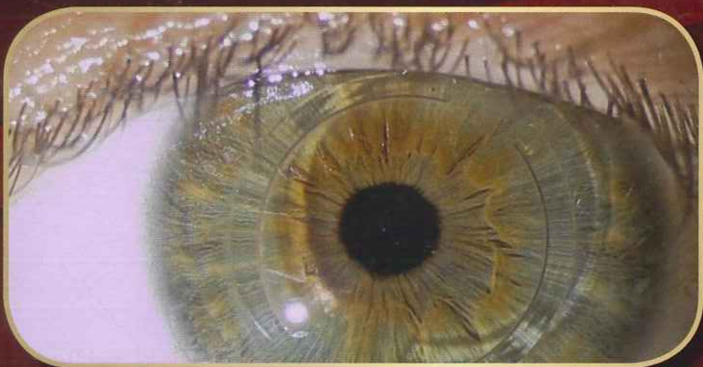
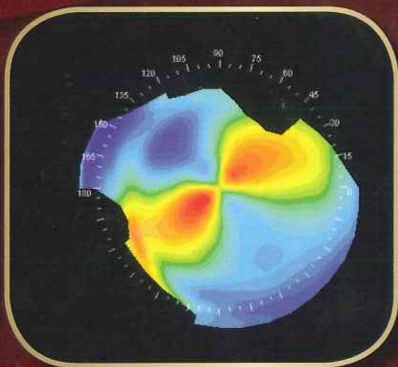
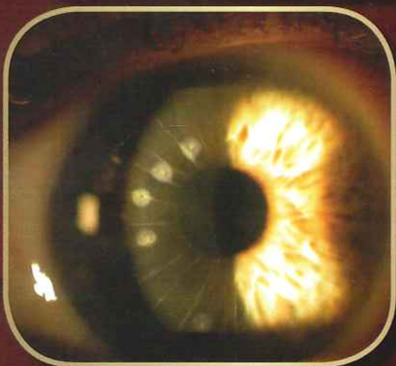
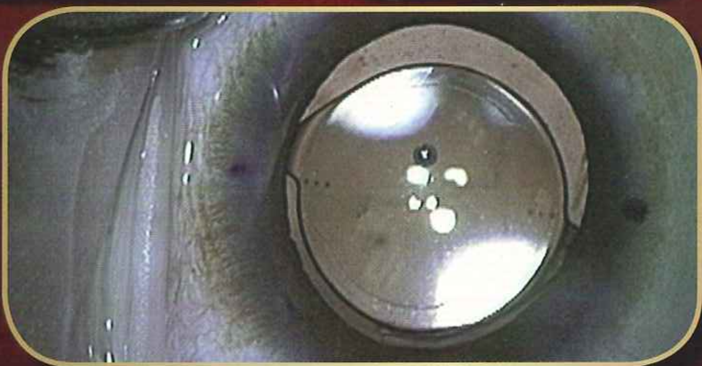
Second Edition

A Complete Surgical Guide for Correcting Astigmatism

An Ophthalmic Manifesto

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Chapter 19

Other Toric Intraocular Lenses

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Why Do We Need a Toric Intraocular Lens?

Astigmatism as a refractive error can be disabling, affecting the quality of vision and quality of life of many patients. Approximately 18% to 23% of cataract patients have at least 1.5 diopters (D) of pre-existing astigmatism, 8% to 10% of the population present with at least 2.25 D of astigmatism, and approximately 2% present with at least 3.00 D of astigmatism. Advances in the ability to correct the refractive errors of cataract patients with astigmatism have gained interest in recent years.[1-4]

As mentioned in previous chapters, various surgical procedures exist to correct astigmatism, such as limbal relaxing incisions (LRIs), astigmatic keratotomy, photorefractive keratectomy (PRK), and laser-assisted in situ keratomileusis (LASIK). The advantages and limitations of these procedures have been well documented. In the case of incisional refractive surgery, the results are variable and are dependent on the depth and length of the incisions, the size of the optical zone, the patient's age, and the type of astigmatism. The skill of the surgeon is just as important. In addition, the risks of over- and undercorrection, perforation, and wound gap also need to be considered.[4-8] With regard to excimer laser surgery, cost is a major disadvantage. Complications, even though infrequent, such as loss of best-corrected visual acuity, a decentered ablation zone, flap complications, night vision difficulties, and regression, must be kept in mind. In addition, in all of these techniques, the amount of cylinder that can be corrected is limited. For this reason, in cases of high astigmatism, these procedures are associated with poor visual quality and low predictability.[1-8]

The introduction of toric intraocular lenses (IOLs) provides an opportunity for a more precise correction of the astigmatism. The concept of neutralizing congenital corneal astigmatism using a rigid polymethylmethacrylate (PMMA) toric lens was first developed by Shimizu in 1992, the same year in which Grabow and Shepherd implanted the first foldable silicone toric plate-haptic IOL.

Henderson BA, Gills JP.
A Complete Surgical Guide for Correcting Astigmatism: An Ophthalmic Manifesto, Second Edition (pp. 169-182).

For successful surgery to be achieved with a toric lens, appropriate selection of IOL power and adequate rotational stability are essential to avoid the induction of astigmatism and to reduce pre-existing astigmatism.[9-11]

The incision size is another major determining factor in surgical success, having the potential to greatly modify the results of the toric IOL surgery. Nowadays, there exists a general trend toward smaller incision sizes, thus reducing surgically induced astigmatism (SIA). Performing microincisional cataract surgery (MICS), which makes use of incisions smaller than 2 mm in length combined with toric IOL implantation, is more effective and precise in correcting pre-existing corneal astigmatism. There are toric IOLs that can be implanted through 1.7-mm incisions, such as the Acri.Comfort 646TLC and the Acri.LISA 466TD (Carl Zeiss Meditec, Jena, Germany), which, in our studies, we have found to be appropriate for MICS.[11,12]

As mentioned earlier, rotational stability is also crucial for a successful surgery. It has been estimated that approximately 1 degree of off-axis rotation results in a loss of up to 3.3% of the lens cylinder power. When the toric lens rotates 30 degrees, the cylinder power is completely lost. A number of studies regarding rotational stability and its evaluation have been reported.[1,2,10,13,14]

Implantation of a toric IOL is an option for astigmatic correction at the time of cataract surgery for the following reasons:

1. It preserves the corneal integrity by avoiding alteration into the stromal lamellae, and therefore there is no risk of regression. It is safe, and the results are more predictable.
2. The technique is a second option for the surgeon in cases in which there is a refractive error. The IOL can be repositioned or replaced to achieve astigmatic correction.
3. It is a simple procedure without a long learning curve.
4. This procedure does not require special instruments or nomograms.
5. It avoids SIA and is effective in correcting high corneal astigmatism, thus improving patient quality of vision and quality of life.

This chapter describes the toric IOLs available in Europe and worldwide.

Toric Intraocular Lenses Available in Europe

The following are toric lenses available in Europe for the correction of high corneal astigmatism. The discussion is not exhaustive, however. Other toric IOLs are also available or are still under study in Europe.

HumanOptics

Dr. Schmidt Intraocularlinsen GmbH (Sankt Augustin, Germany), a company of HumanOptics (Erlangen, Germany), has developed the MicroSil toric IOL, a 3-piece, foldable, toric IOL that is available in spherical powers between –3.00 D and 31.00 D and cylindrical powers ranging from 1.00 D to 30.00 D (availability of cylinder depending on combination with sphere).

There are 2 types of MicroSil toric IOLs that can be implanted in the capsular bag, namely the MS6116TU (Torica-s) and the MS6116T-Y (Torica-sY).The difference is that the MS6116T-Y incorporates blue light protection.[15] The optic of the lens is marked with 2 peripheral lines, which serve as a guide to align the IOL with the steep axis. Both lenses can be implanted through an incision of 3.2 mm to 3.4 mm.

Table 19-1 shows the features of the MS6116 IOLs. Figure 19-1 shows the design of the MS6116TU and MS6116T-Y lenses.

The Z-design ensures the rotational stability and helps to balance mechanical forces during postoperative capsular bag shrinkage. However, careful attention must be paid during implantation due to the extended Z-haptics of this toric IOL. Because of the shape of the haptics, implanting the MicroSil toric lens is more difficult than inserting a conventional posterior chamber IOL. In a report of a study of 36 eyes implanted with the MicroSil 6116TU, Fox et al proposed creating an oval-shaped capsulorrhexis to avoid difficulties in implanting these lenses, thereby helping to prevent complications.[16]

The company has also designed other models of IOLs as alternatives for special cases, such as in aphakia or traumatic cataracts. These are the MS614T(Torica-sS) and the MS614T-Y (Torica-sS-Y with blue light protection) for sulcus fixation, with loop modified haptics. These lenses are available in spherical powers between -3.00 D and 31.00 D and cylindrical powers ranging from 1.00 D

Table 19-1

Features of the MS6116TU and MS6116TY IOLs

Feature	MS6116TU	MS6116TY
Type	Toric posterior chamber IOL (3-piece, foldable, 360-degree sharp optic edge)	Toric posterior chamber IOL with blue light protection (3-piece, foldable, 360-degree sharp optic edge)
Optic material	Silicone elastomer with UV-absorber	Silicone elastomer with UV-absorber and yellow coloring agent
Haptic material	High-molecular PMMA	
Optic shape	Spherical anterior surface; Toric posterior surface	
Haptic shape	Undulated Z-loop	
Spherical D range	0.50 D steps: 15.00 to 25.00 D 1.00 D steps: -3.00 D to 14.00 D/26.00 D to 31.00 D	
Cylinder D range	0.50 D steps: 1.00 D to 3.00 D 1.00 D steps: 4.00 D to 30.00 D max	
	Availability of cylinder depending on combination with sphere	
A-constant (est.)	118.6	
Cylinder axis	The 2 thin lines in the periphery of the optic indicate the plus-cylinder axis	

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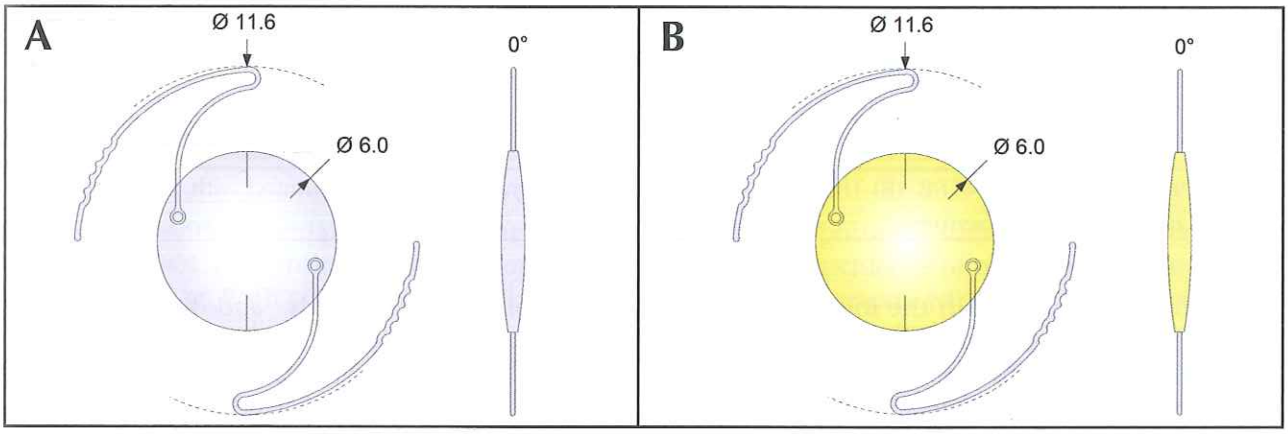

Figure 19-1. (A) The MS6116TU with 2 thin lines in the periphery of the optic indicating the plus-cylinder axis. (B) The MS6116TY with blue-light protection. Reprinted with permission from HumanOptics, Erlangen, Germany.

to 30.00 D (availability of cylinder depending on combination with sphere). Figure 19-2 shows the design of the MS614T and MS614T-Y toric IOLs.

In cases of residual refractive error, the company suggests the use of the MicroSil Add On IOL (MS714 TPB or the MS714TPB-Y with blue light protection) for sulcus fixation, with C-loop modified undulatep haptics. These lenses are available in cylindrical powers from +1.00 D to +6.00 D in increments of 1.00 D with a spherical equivalent power of 0 D. Additionaly, there are other powers that are available on request.[16] Figure 19-3 shows the design of the MS714TPB (Torica –sPB) and the MS714TPB-Y(Torica –sPBY).

It is important for the reader to know that since Dr. Schmidt Intraocularlinsen is a subsidiary of HumanOptics, all of their lenses are available under both labels and therefore have 2 different

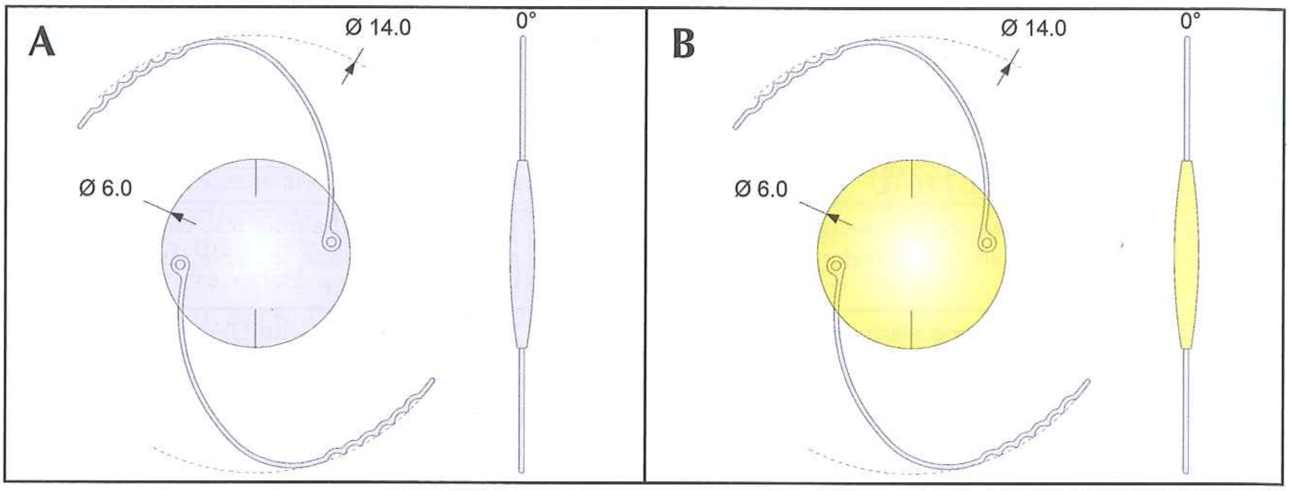

Figure 19-2. (A) The MS614T toric IOL for sulcus fixation. (B) The MS614T-Y toric IOL for sulcus fixation with blue-light protection. Reprinted with permission from HumanOptics, Erlangen, Germany.

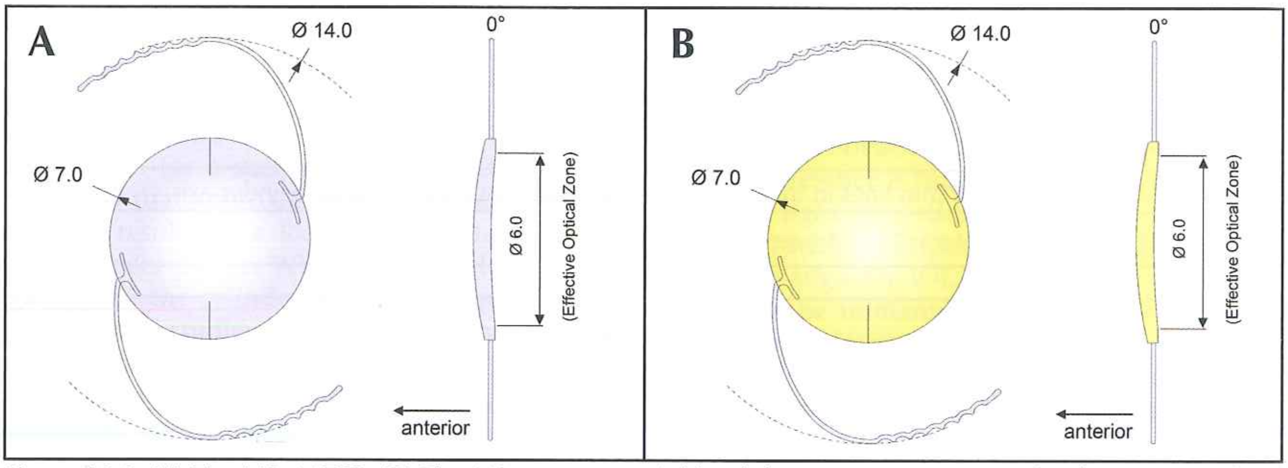

Figure 19-3. (A) The MS714TPB. (B) The MS714TPB-Y with blue-light protection. Reprinted with permission from HumanOptics, Erlangen, Germany.

names for each product. In the following list, the first name belongs to the Dr. Schmidt brand and the second name belongs to the HumanOptics brand:

- MS6116TU or Torica-s
- MS6116T-Y or Torica-sY
- MS614T or Torica-sS
- MS614T-Y or Torica-sSY
- MS714TPB or Torica-sPB
- MS714TPB-Y or Torica-sPBY

Oculentis

Oculentis (Berlin, Germany) offers 2 models of standard toric IOLs and 2 models with customized ranges, whose differences are in power of correction, overall length, and haptics design, among other features[17]:

- Lentis LS-313T: Standard IOL with types T1, T2, and T3 for correction of cylinder of +1.50 D, +2.25 D, and + 3.00 D, respectively.
- Lentis LU-313T: Customized 1-piece with aspherical surface posterior, monotoric anterior, and plate-haptics.
- Lentis LS-312T: Standard IOL with types from T1 to T5 for correction of cylinder of +1.50, +2.25, +3.00, +3.75, and +4.50, respectively.
- Lentis LU-312T: Customized 1-piece with aspherical surface posterior, monotoric anterior, and C-haptics.

Table 19-2 shows the features of the different IOls, and Figure 19-4 shows their designs.

Table 19-2

Features of Lentis Toric IOLs

Feature	*Lentis LS-313T*	*Lentis LS-312T*	*Lentis LU-313T*	*Lentis LU-312T*
Type	One-piece acrylic IOL			
Optic size	6 mm			
Overall length	11.0 mm	12.0 mm	11.0 mm	12.0mm
Haptic angulation	0 degrees			
Optic	Biconvex aspherical surface—posterior; monotoric—anterior			
Design	Optic and plate-haptic with 360-degree square edge	Optic and C-haptic with 360-degree square edge	Optic and haptic with 360-degree square edge	Optic and C-haptic with 360-degree square edge
Material	HydroSmart copolymer consisting of acrylates with hydrophobic surface, UV absorbing			
Available diopters	Main value: +15.00 D to +25.00 D (0.50 D) Cylinder value: T1: +1.50 D; T2: +2.25 D; T3: +3.00 D	Main value: ±15.00 D to +25.00 D Cylinder value: T1: +1.50; T2: +2.25; T3: +3.00; T4: +3.75; T5: +4.50	Main value: ±0.00 D to +30.00 D Cylinder value: +0.25 D to +12.00 D	
Estimated A-factor (optic)	118.1 (SRK/T)	118.7 (SRK/T)	118.1 (SRK/T)	118.2 (SRK/T)
Recommended incision size	2.6 mm			

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The Oculentis calculator allows the correct selection of IOL and optimal axis location within the capsular bag. Both customized models are also available with blue light filter.

A new IOL is being studied—the Lentis Mplus toric, a model toric and multifocal for correction of presbyopia and astigmatism. It provides an addition of 3.00 D and a correction of cylinder up to 12.00 D. Our initial experience with this IOL has been good.

Rayner

The British company Rayner Intraocular Lenses Ltd. (East Sussex, UK), introduced its T-*flex* Aspheric toric IOLs (models 573T and 623T) to the market as an alternative to toric IOLs with a restricted range of torus. With the T-*flex* Aspheric IOL, the cylinder is implemented on the anterior surface of the optic and the Amon-Apple Enhanced Square Edge on the posterior surface, which accounts for the reduced incidence of posterior capsule opacity (PCO). Furthermore, with its patented anti-vaulting haptic (AVH) technology, this lens achieves optimal centration and torsional stability. It is manufactured from Ray*acryl* hydrophilic acrylic co-polymer, which presents with high biocompatibility, low PCO, low silicone oil adherence, and optical purity due to the absence of vacuoles or glistenings. Model 623T is especially suitable for myopic eyes and designed for low- and medium-power lenses. Model 573T is designed for normal and hyperopic eyes and for higher power lenses.[18] Table 19-3 describes the features of the T-*flex* Aspheric toric IOLs. Figure 19-5 shows the design of the T-*flex* Aspheric IOL.

In June 2006, Rayner launched its M-*flex* T multifocal IOL with added toric correction. Standard multifocal IOLs are contraindicated for patients with greater than 1.5 D of astigmatism, but with

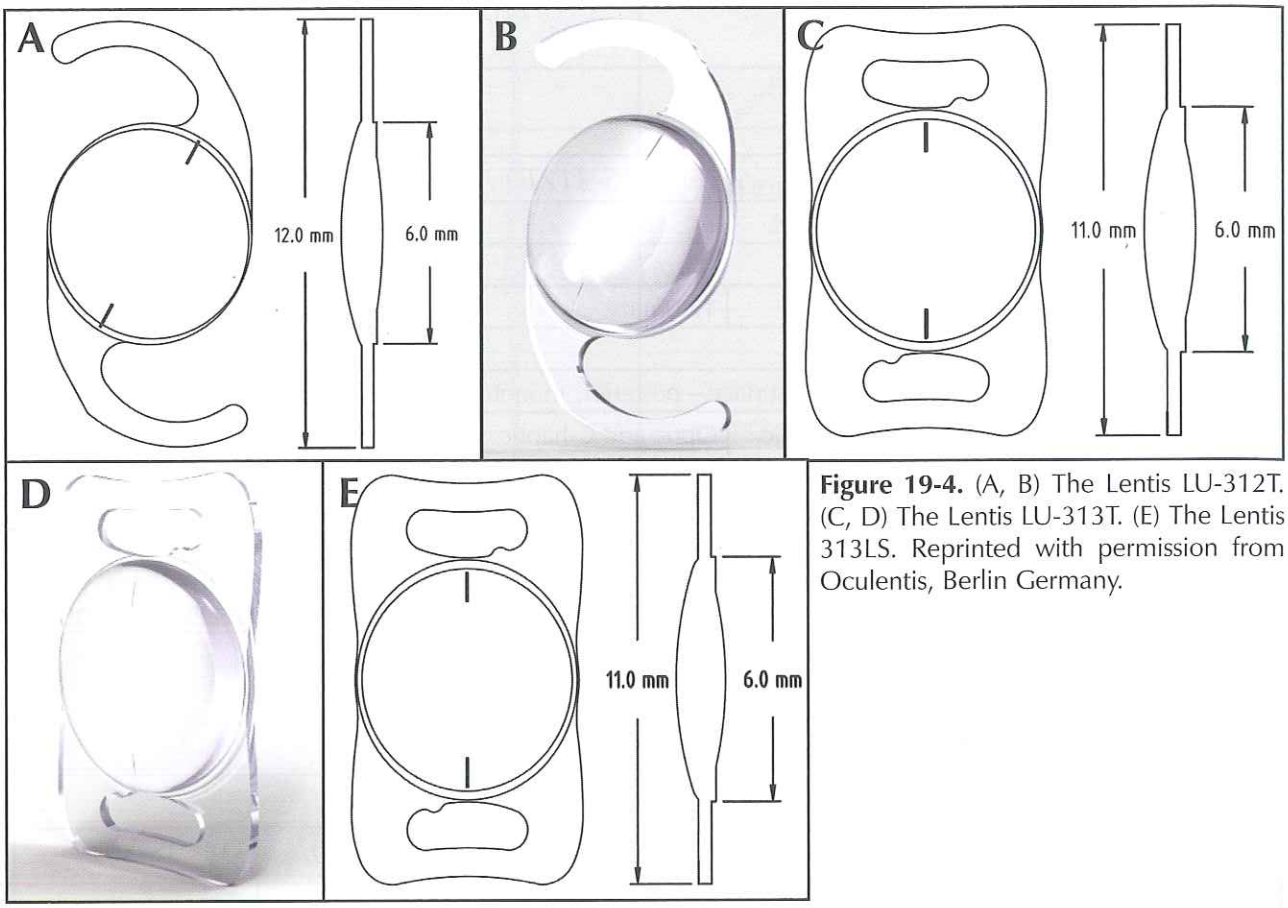

Figure 19-4. (A, B) The Lentis LU-312T. (C, D) The Lentis LU-313T. (E) The Lentis 313LS. Reprinted with permission from Oculentis, Berlin Germany.

Table 19-3

Features of the T-*flex* Aspheric Toric IOL

Features	T-*flex Aspheric IOL*
Type	Ray*acryl* IOL-enhanced square edge
Optic size	573T: 5.75 mm; 623T: 6.25 mm
Overall length	573T: 12.0 mm; 623T: 12.5 mm
Optic shape	Anterior surface of the optic is toric
Material	Ray*acryl* hydrophilic acrylic co-polymer
Available diopters	Spheres: +6.00 D to +30.00 D in 0.50 D steps Cylinders: +1.00 D to +6.00 D in 1.00 D steps
	Premium range (manufactured specifically to order): Spheres: –10.00 D to +35.00 D maximum (sphere + cylinder) in 0.50 D steps Cylinders: +1.00 D to +11.00 D in 0.25 D steps
Estimated A-factor (optic)	118.9

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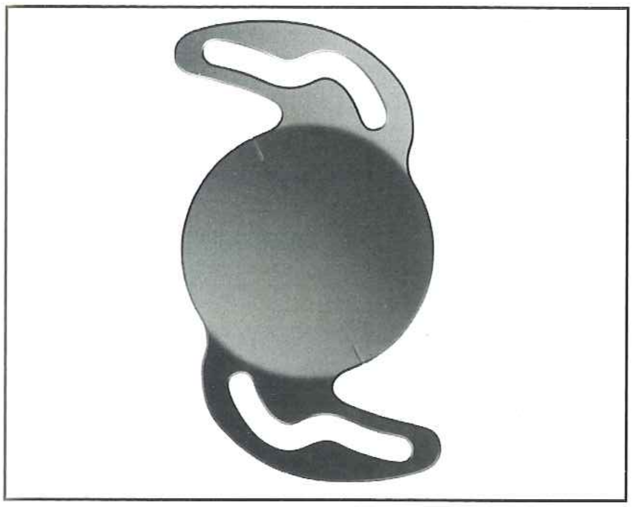

Figure 19-5. Design of the T-*flex* Aspheric IOL. Reprinted with permission from Rayner, East Sussex, UK.

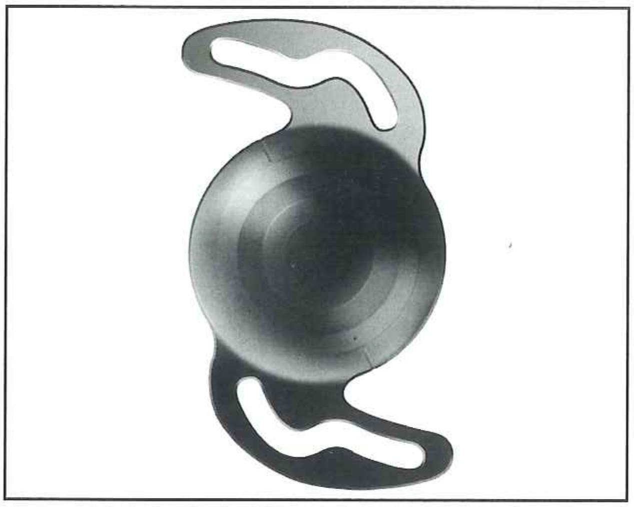

Figure 19-6. Design of the M-*flex* T toric IOL. Reprinted with permission from Rayner, East Sussex, UK.

Table 19-4

Features of the M-*flex* T Multifocal Toric IOL

Features	*588F for Base Powers > 25.0 D*	*638F for Base Powers ≤ 25.0 D*
Optic diameter	5.75 mm	6.25 mm
Overall length	12.0 mm	12.5 mm
A-constant	118.6	
Standard power	Maximum spherical equivalent: +14.00 D to +32.00 D in 0.50 D steps	
	Cylinder: 2.00 D	
	Addition: +3.00 D or +4.00 D	
Premium range (manufactured to order)	Maximum spherical equivalent: +14.00 D to +32.00 D in 0.50 D steps	
	Cylinder: +1.00 D to +1.50 D and +2.50 D to +6.00 D in 0.50 D steps	
	Addition: +3.00 D or +4.00 D	

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the Rayner M-*flex* T multifocal toric IOL, the combination of both allows the potential benefit of reducing spectacle dependence even in patients with significant corneal astigmatism.[19]

The M-*flex* T multifocal IOL is based on a multizone refractive aspheric optic technology, with either 4 or 5 annular zones depending on the IOL base power. It provides +3.0 D or +4.0 D of additional refractive power at the IOL plane, which is equivalent to +2.25 D or +3.00 D at the spectacle plane. This lens can correct a standard cylinder of 2.00 D and nonstandard power range of 1.00 D to 1.5 D and 2.5 D to 6.00 D in 0.5-D increments.

This IOL offers an excellent multifocal correction without the problem of halos and glare. Furthermore, it offers all of the advantages as the T-*flex*, as described previously.[20,21] Rayner M-*flex* T toric IOLs are currently manufactured as models 588F and 638F, having a 5.75-mm optic and a 6.25-mm optic, respectively. Table 19-4 and Figure 19-6 show the features and design of the M-*flex* T toric IOL.

For cases of postsurgical and residual ametropia, Rayner designed the Sulco*flex* Toric 653T pseudophakic supplementary IOLs. Their unique design, compared to conventional piggyback lenses, ensures that the potential for contact between

Table 19-5

Features of the Sulco*flex* Toric IOL

Features	Sulco*flex* *653T*
Optic body diameter	6.5 mm
Overall length	14 mm
Haptic angulation	10 degrees
Optic configuration	Anterior convex, posterior concave
Standard power	Sph. equivalent: –3.00 D to +3.00 D in 0.50 D steps
	Cylinder: +1.00 D to +3.00 D in 1.00 D steps
Premium range (manufactured to order)	Sph. equivalent: –6.00 D to +6.00 D in 0.50 D steps
	Cylinder: +1.00 D to +6.00 D in 0.50 D steps

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the 2 implants is minimized and reduces the likelihood for additional refractive error and optical aberration that can occur due to optic distortion caused by a narrow area of contact between the IOLs. These lenses possess a large optic diameter, which ensures quality of vision with reduced optic iris capture. Their round optic edge contributes to low rates of dysphotopsia, and their undulating haptic allows better IOL centration and rotational stability. Moreover, the haptic angulation ensures uveal clearance, thereby avoiding pigment dispersion and further reducing the risk of optic iris capture. The Sulco*flex* Toric 653T can correct cylinders of +1.0 D to +3.0 D in 1.0-D increments and a customized cylinder range of +1.00 D to +6.00 D in 0.5-D increments. Table 19-5 and Figure 19-7 show the features and design, respectively, of the Sulco*flex* Toric 653T.

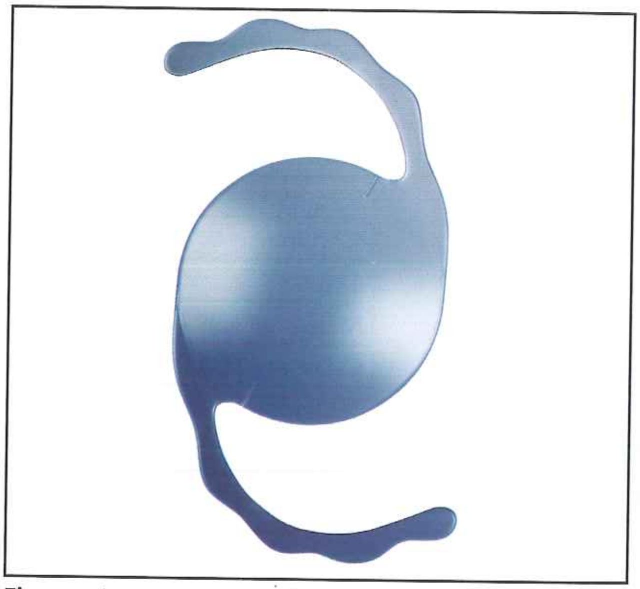

Figure 19-7. Design of Sulco*flex* Toric 653T IOL. Reprinted with permission from Rayner, East Sussex, UK.

Carl Zeiss Meditec

In September 2007, Acri.Tec AG was acquired by Carl Zeiss Meditec. The acquisition enabled Zeiss to offer the innovative Acri.Comfort 646TLC, now called AT TORBI 709M, the first bitoric, aspherical, foldable, one-piece, acrylic polymer posterior chamber lens for endocapsular fixation for true MICS (less than 2-mm incisions) ensuring a good quality of vision.

As mentioned earlier, a maximum reduction in incision size (MICS) to avoid the induction of astigmatism and of aberrations, which combined with toric IOL implantation, is more effective and precise in correcting pre-existing corneal astigmatism, improving the optical quality of the cornea.[13,14]

The AT TORBI 709M IOl has an optical zone of 6-mm diameter, an overall length of 11 mm, and an A-constant of 118.3, with spherical powers available from –10.00 D to +32.00 D and cylinder powers from +1.00 D to +12.00 D. The cylinder values outside of the standard range are manufactured individually. This IOL presents a good centration and rotational stability. Table 19-6 and Figure 19-8 show the features and design of the lens.[22,23]

Table 19-6

Features of the Acri.Comfort 646TLC/AT TORBI 709M

Features	*Acri.Comfort 646TLC/AT TORBI 709M*
Optic design	Monofocal, bitoric, aspheric (aberration neutral)
Optic diameter	6 mm
Total diameter	11 mm
Haptic angulation	0 degrees
Edge	Square edge; optic and haptic
Incision size	1.5 to 1.7 mm
Material	Hydrophilic acrylic 25% with hydrophobic surface
Diopter range	Sphere: –10.00 D to +32.00 D (0.50 D steps)
	Cylinder: +1.00 D to +12.00 D (0.50 D steps)
A constant	Lens can be calculated online via Z CALC

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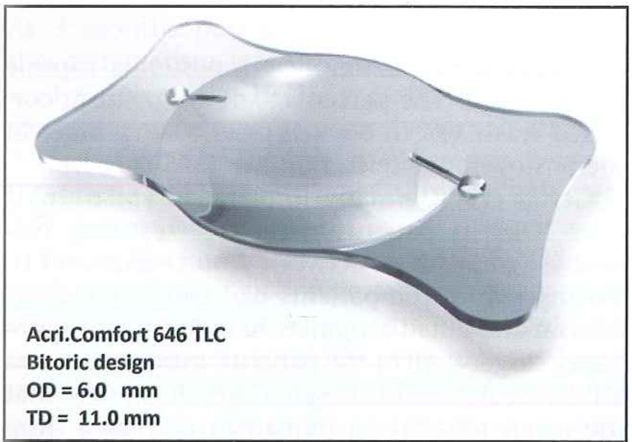

Figure 19-8. Design of the Acri.Comfort 646TLC. Reprinted with permission from Carl Zeiss Meditec, Jena, Germany.

Recently, the company unveiled the new monotoric bifocal Acri.LISA toric 466TD, now called AT LISA Toric 909M, the first aspheric toric multifocal IOL for true MICS. This lens combines the visual performance of the AT LISA bifocal lens for near, intermediate, and distance with the stable astigmatic correction of the AT TORBI bitoric lens. The near vision segment of the IOL is +3.75 D and astigmatism correction is achieved through the front surface. This model is also available with violet light filter known as AT LISA Toric 909MV.

The lens is ideal when we have a patient with presbyopia and astigmatism more than 2.00 D.

The LISA name was conceived as an acronym for the characteristics of the lens:

- Light distributed asymmetrically between distant 65% and near focus 35% for improved intermediate vision and less halos and glare
- Independence from pupil size due to high-performance diffractive refractive microstructure covering the complete optical diameter
- Smooth micro phases (SMP) technology, conferring to the lens a surface without any right angles for ideal optical imaging quality with reduced light scattering
- Aspheric optic for better contrast sensitivity and depth of field, sharper vision, and an extended intermediate range

The AT LISA toric 909M offers cylindrical correction from +1.00 D to +12.00 D in 0.5 D increments. Table 19-7 and Figure 19-9 show the characteristics and design of this lens.

Outcomes of the Different Toric Intraocular Lenses Available on the Market

HumanOptics

Dr. Fox carried out a clinical evaluation of 36 eyes implanted with MS6116TU lenses between 2004 and 2007.[16] All eyes underwent routine

Table 19-7

Features of the Acri.LISA 466TD/AT LISA Toric 909M

Features	*Acri.LISA 466TD/AT LISA Toric 909M*
Lens design	Single piece, diffractive +3.75 add, toric IOL with square edge of optic and haptic.
Optic design	Multifocal, anterior toric, aspheric (aberration correcting). Available with violet light filter: AT LISA 909MV
Optic diameter	6 mm
Total diameter	11 mm
Haptic angulation	0 degrees
Incision size	1.5 mm to 1.7 mm
Material	Hidrophilic acrylic 25% with hydrophobic surface.
Diopter range	Sphere: –10.00 D to +32.00 D (0.50 D steps)
	Cylinder: +1.00 D to +12.00 D (0.50 D steps)
A Constant	Lens can be calculated online via Z CALC

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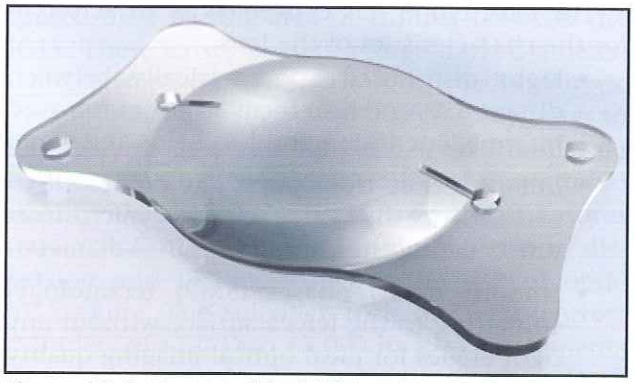

Figure 19-9. Design of Acri.LISA toric 466TD. Reprinted with permission from Carl Zeiss Meditec, Jena, Germany.

phacoemulsification cataract surgery with a 3-mm temporal incision at Chichester Nuffield Hospital or Goring Hall Hospital in the United Kingdom. Results showed a mean pre-existing corneal astigmatism of 2.95 ± 1.05 D (SD 1.7 to 5.84).[16] At 9.08 weeks, the average postoperative refractive cylinder was –0.69 ± 0.38 D (range of 0.00 D to –1.75 D) and spherical equivalent was –0.44 ± 0.34 D (range 0.25 D to –1.25 D), respectively. The lens showed good rotational stability in all but 1 of the cases that was 7 degrees off axis. In spite of this, a second operation was not required to correct the axis change. Furthermore, there was no appearance of significant posterior capsule opacification. The percentage of astigmatism corrected was 73%. In 86% of cases, the cylinder in the postoperative refraction was 0.75 D or less.

Gerten et al (Germany) implanted 24 MS6116TU toric IOLs in patients with a pre-existing corneal astigmatism of between 2.00 D and 6.00 D. Twenty-two of the patients had congenital astigmatism and 2 had astigmatism induced by keratoplasty surgery. All of the patients' astigmatism was stable, regular, and orthogonal. Results showed that the mean refractive astigmatism decreased from –3.15 ± 1.61 D preoperatively to –0.36 ± 0.80 D postoperatively. All of the eyes presented with less than 10 degrees rotation. The high stability of the toric lens demonstrated by these results can be attributed to the Z-haptic design of the lens.[15]

Schipper reported 2 cases with 12.00 D and 18.00 D of pre-existing corneal astigmatism who underwent cataract surgery with implantation of the MicroSil toric IOL.[15] After implantation of the lens, the patients' refractive astigmatism was reduced to values of between zero and 1.00 D. After 2-years' follow-up, no rotation or decentration was observed.

Based on these studies, the MS6116 allows a precise and predictable correction of pre-existing corneal astigmatism and, likewise, exhibits good rotational stability.

Rayner

Dr. Clive Peckar (UK), reported his experience with the T-*flex* Aspheric toric IOL at the XXIV Congress of the European Society of Cataract and Refractive Surgeons (ESCRS), emphasizing the excellent centration and stability of the IOL. He had implanted the T-*flex* Aspheric lens in 17 eyes with pre-existing corneal astigmatism of 2.25 D to 4.5 D. All patients underwent routine phacoemulsification surgery with implantation of the lens through a 3-mm incision. Results showed a mean residual refractive cylinder of 0.95 D. All of the IOLs rotated less than or equal to 7 degrees.[24]

During the ESCRS Stockholm Convention in 2007, Harman and associate (Hillingdon Hospital, UK) presented the results of implanting the T-*flex* Aspheric toric IOL through 2.8-mm incisions in 20 eyes with a mean pre-existing corneal astigmatism greater than 2.5 D. Mean preoperative refractive astigmatism and keratometric astigmatism were 3.94 ± 1.01 D and 3.01 ± 0.74 D, respectively. At 3 months postoperatively, the mean refractive astigmatism was 0.78 ± 0.73 D, and vector analysis using the Holladay-Cravy-Koch method showed a reduction in refractive astigmatism of 3.91 ± 1.21 D. The mean difference between intended and actual IOL cylinder axis was 3.55 degrees (range 0 to 12).

Daniel Black (Australia), during the ESCRS convention in Berlin 2008, reported the results of his consecutive series of 40 patients implanted with the T-*flex* Aspheric toric IOL. The patients had a mean preoperative cylinder of 2.2 D. At 1-month postoperatively, the mean postoperative cylinder was 0.3 D. Thirty-five of the 40 eyes were within 5 degrees of their intended axis, and the other 5 IOLs did not rotate more than 10 degrees.[25]

These studies demonstrate that the Rayner T-*flex* Aspheric toric IOL is effective in reducing visually significant keratometric astigmatism. Further, the lens showed no significant rotation within the capsular bag at 3-months postoperatively.

During the ESCRS convention in Berlin in 2008, Julián Cezón presented his initial experience with the toric multifocal IOL M-*flex* T, having implanted the lens in 6 eyes of 3 patients. The first patient was a 51-year-old man with a spherical error of +4.5 D in both eyes and a cylinder of –5.0 D at 25 degrees in his right eye and –4.25 D in his left eye. At 12 months, he achieved a near distance visual acuity of J1 in his right eye and J2 in his left eye; and uncorrected visual acuity (UCVA) of 20/20 in his right eye and 20/25 in his left eye.[26] Based on the results from the 3 patients, Cezón concluded that the M-*flex* T multifocal toric IOL reduced spectacle dependence and corrected significant pre-existing corneal astigmatism.

Carl Zeiss Meditec

We have experience implanting the Acri.Comfort 646TLC IOL, now AT TORBI 709M IOL, with excellent results. We carried out a study with 21 eyes of 12 patients who had preexisting astigmatism from 2.00 D to 9.50 D. The IOL was implanted through an incision of 1.8 mm (MICS).[27] The mean preoperative sphere and preoperative cylinder was +0.67 D ± 7.20 D (range –10.00 D to +9.25 D) and –4.46 ± 2.23 D (range –2.00 D to -9.50 D), respectively.

Three months postoperative results showed 76.1% of the eyes had UCVA of 20/40 or better and 85.7% of the eyes achieved a BCVA of 20/30 or better. The percentage of astigmatism corrected was 91% and the residual refractive cylinder was –0.45 D ± –0.63 D. The mean keratometric changes before surgery and after surgery were not statistically significant.

The mean toric IOL axis rotation was –1.75 degrees ± 2.93 degrees (range 0 degrees to –10 degrees) 3 months postoperatively. 95.7% of eyes (20 cases) had a rotation ≤ 5 degrees and 1 eye had an IOL rotation of 10 degrees (4.3%). No complications related to the IOL were observed in this study (intraoperative or postoperative).

At 3 months follow up, no eyes developed posterior capsule opacification. No eyes needed secondary surgery to reposition the toric IOL.

Figure 19-10 shows a photograph of a patient with the Acri.Comfort 646TLC IOL implanted in the left eye at 3 months after surgery.

Recently, we have carried out the implantation of the AT LISA Toric 909M IOL, which also resulted in excellent outcomes. An example is a 53-year-old female patient with a refraction of +9.00 –3.00 X 25 in the right eye and +9.25 –3.00 X 5 in the left eye, BCVA of 0.98 in both eyes, and near vision of J1 in both eyes.

Her eyes were implanted with 3 D of cylindrical power at 111 degrees in the right eye and at 91 degrees on the left. At 2 months, the refraction was -0.50 at 110 degrees in her right eye and -0.50 at 95 degrees in her left with UCVA of 1 in both eyes and binocular near vision of J1.

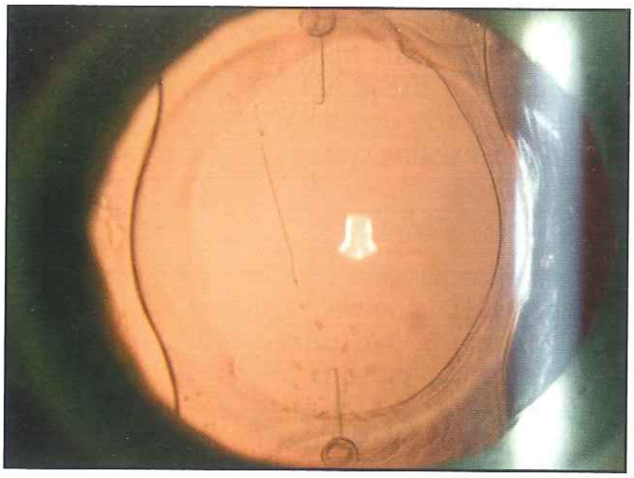

Figure 19-10. Patient with the IOL implanted in the left eye, at 3 months postoperatively.

Based on our results, the AT TORBI 709M toric IOL for true MICS is effective in correcting moderate to high astigmatism, thus improving the quality of vision. Furthermore, the AT LISA toric 909M IOL allows greater spectacle independence and improves the quality of life of the patients implanted with this lens.

Introducing Toric Intraocular Lenses in Your Practice: What Are the Indications and How to Analyze the Outcomes

Without a doubt, toric IOLs are a predictable and stable alternative for correcting pre-existing corneal astigmatism. In our practice, when patients present to us, we first determine the power and axis of the cylinder, the age of patient, and the status of the fellow eye. We also evaluate the requirements of our patients. For example, we note if they are interested in correcting their presbyopia simultaneously and if they have pre-existing astigmatism. Nowadays, there are different models of toric IOLs and multifocal toric IOLs providing both presbyopic and astigmatic correction with the advantage of minimizing if not avoiding corneal manipulation. A limiting factor for using these IOLs, however, could be the cost.

After selection of the toric IOL, it is essential for the surgeon to analyze the effectiveness of the correction of the astigmatism. For a reliable analysis of astigmatism, values should be represented as vectors so that standard descriptive statistics can be applied appropriately. This has been performed by many authors, such as Holladay, Naeser and Hjotdal, Thibos and Horner, and Alpins, among others.[28-33]

Descriptive statistics cannot be applied to polar coordinates because the cylinder in magnitude and axis are not independent (orthogonal) parameters. Therefore, the polar values should be converted to Cartesian values (each data point must be converted into an x, y coordinate system). These aspects are taken into consideration by the Alpins method of vector analysis, which has been described extensively in many studies and journal articles. We recommend this method because it considers 2 aspects—first, the vertex adjustment for the refractions is performed at the spectacle plane or in the phoropter, avoiding measurement errors when working with keratometric data, and second, the angles of astigmatism are doubled so that 0 degrees and 180 degrees are equivalent.[33-37]

Finally, because our goal is emmetropia, regardless of the method of astigmatic analysis that we choose, we should always keep in mind that an evaluation of the outcomes postoperatively is mandatory so that future procedures can be improved and further innovations in the field of toric IOLs may be developed.

Conclusion

Toric IOLs are safe and predictable alternatives for correcting astigmatism in patients with cataracts and pre-existing corneal astigmatism. The new designs minimize the risk of IOL rotation, thus providing a significant improvement of the visual acuity and quality of vision.

Toric IOLs for high corneal astigmatism that can be implanted through MICS incisions of less than 2 mm are now available and have been demonstrated to be effective in increasing spectacle independence and improving patient quality of life. The benefits of MICS are maximized with the use of toric IOLs, as surgically induced astigmatism is reduced if not eliminated with the combination of the astigmatically neutral incisions of MICS and the efficiency of these new toric IOLs.

Finally, the refinement of refractive outcomes is both a major challenge and an opportunity faced by today's cataract surgeons. Therefore, a thorough and exhaustive evaluation of one's patients and their lifestyles is necessary so that a customized selection of IOL and analysis of outcomes can contribute to improvement of the quality of cataract surgery as well as further innovations in the field.

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