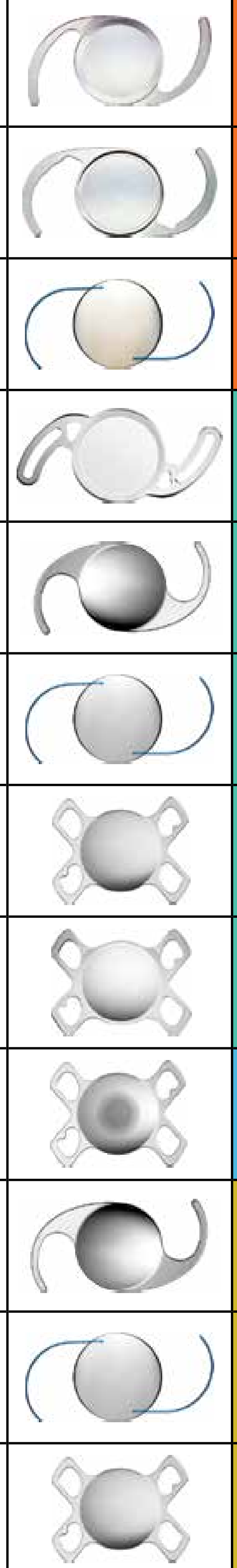
Family of Aspheric Intraocular Lenses

AARIS Acrylic IOL with ADAPTIV OPTICS | AQUA-SENSE® Acrylic IOL with ADAPTIV OPTICS | BIOVUE Heparin Coated IOL with ADAPTIV OPTICS



Model	EC-1 PAL	EC-1RH PAL	EC-3 PAL	Aqua SI	Aqua-Sense® PAL	Aqua-Sense III PAL	Aqua4V PAL	Aqua4 RM	OptiVis™ Multifocal	BioVue® PAL	BioVue3 PAL	BioVue4V PAL
Material	Hydrophobic	Hydrophobic	Hydrophobic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic	Hydrophilic
Yellow Available	✓	✓		✓	✓			✓				
Aspheric	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heparin	EC-1H PAL	✓								✓	✓	✓
Preloaded Available	HPI 4.0 to 30.0D	HPI 4.0 to 30.0D	Lens-prep+™ 4.0 to 26.0D									
Min. Incision Size	2.2 mm	2.0 mm**	2.6 mm	1.8 mm	2.2 mm	2.6 mm	2.2 mm	1.8 mm	2.2 mm	2.2 mm	2.6 mm	2.2 mm
Optic Diameter	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm
Overall Diameter	13.0 mm	13.0 mm	13.0 mm	13.0 mm	12.5 mm	13.0 mm	11.0 mm	13.0 mm	11.0 mm	12.5 mm	13.0 mm	11.0 mm
Haptic Angle	5°	5°	5°	Step Vaulted	5°	5°	5°	5°	5°	5°	5°	5°
Design	1-Piece	1-Piece	3-Piece	1-Piece	1-Piece	3-Piece	1-Piece	1-Piece	1-Piece	1-Piece	3-Piece	1-Piece
Ref. Index	1.49	1.49	1.49	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
"A" Constant*	117.8	118.5	117.7	119.0	118.2	118.2	118.4	118.4	118.1	118.2	118.2	118.4
AC Depth*	4.8	5.1	4.8	5.6	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Diopter Range	4.0 to 34.0D	4.0 to 34.0D	4.0 to 34.0D	4.0 to 34.0D	4.0 to 30.0D	4.0 to 30.0D	-10.0 to 30.0D	13.0 to 30.0D	10.0 to 30.0D	4.0 to 30.0D	4.0 to 30.0D	4.0 to 30.0D

* A-Constants and AC Depths are estimated and subject to change due to optimization. For the latest values, please check the ULIB IOL Master website at: http://www.augenklinik.uni-wuerzburg.de/ulib/c1.htm

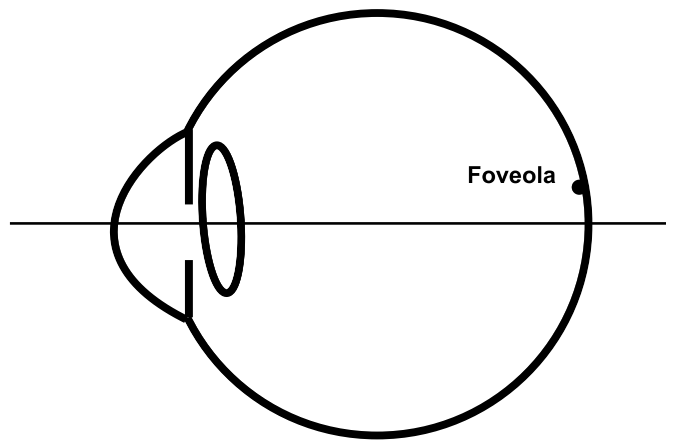
** For dioptres 4.0 to 24.0D only. Minimum incision size for 24.5 to 34.0D is 2.2 mm.

Decentration and Tilt

The optics of all Aaren Scientific PAL lenses are designed to compensate for aberrations of the eye to achieve exceptional optical performance - even in cases of clinically occurring IOL misalignment.

An IOL placed in the posterior chamber of the eye of pseudophakic subjects will generally manifest some tilt and decentration. Decentration means range from about 0.3 to 0.7 mm, while tilt means range from 3 to 7 degrees, with lower numbers reported by more recent studies.[1-5] Secondly, even an IOL perfectly centered in the capsular bag may be significantly decentered with respect to the visual axis.[6] This is because structurally, the human eye is not optically symmetrical, i.e. the optical axis of the eye doesn't generally coincide with its visual axis.

Unlike a camera, the eye is a decentered optical system with non-rotationally symmetric components (Fig 1). The principle elements of the eye's optical system are the cornea, pupil, and the crystalline lens. Each is decentered and tilted with respect to other components rendering an optical system that is typically dominated by coma at the foveola. [7]



The cornea, pupil, and crystalline lens are decentered and tilted with respect to each other rendering the eye a decentered optical system that is different between individuals and eyes within the same individual. The line is centered with respect to the sclera represented here as being spherical. [7]

1. Phillips et al. Measurement of intraocular lens decentration and tilt in vivo. J. Catar Refr Surg.1988;14:129-138 (Average tilt 7.8 deg and decentration of 0.7 mm)
2. Kozaki J. et al Tilt and decentration of the implanted posterior chamber intraocular lens. J. Catar Refr Surg. 1990; 17:592-599 (Average tilt of 7.5 degrees and decentration of 0.68 mm)
3. Auran JD et al. In Vivo Measurements of Posterior Chamber Intraocular Lens Decentration and Tilt. Arch Ophth. 1990;108:75-79 (Average tilt 6.7 deg and decentration 0.7 mm)
4. Taketani F et al. Influence of intraocular lens tilt and decentration on wavefront aberrations. J Catar Ref Surg. 2004;30:2158-2162 (Average tilt 3.4 degrees and decentration 0.31 mm)
5. Mutlu F. et al. Comparison of tilt and decentration of 1-piece and 3-piece hydtophobic acrylic intraocular lenses. J Catar Ref Surg. 2005;31:343-347 (Average tilt 2.7 degrees and decentration 0.39 mm)
6. Altmann G. et al. Optical performance of 3 intraocular lens designs in the presence of decentration. J Catar Ref Surg. 2005;31:574-584
7. Applegate, R. et al. Reference Axis Selection: Subcommittee Report of the OSA Working Group to Establish Standards for Measurement and Reporting of Optical Aberrations of the Eye. Journal of Ref Surg. 2000; 16: S656-S658

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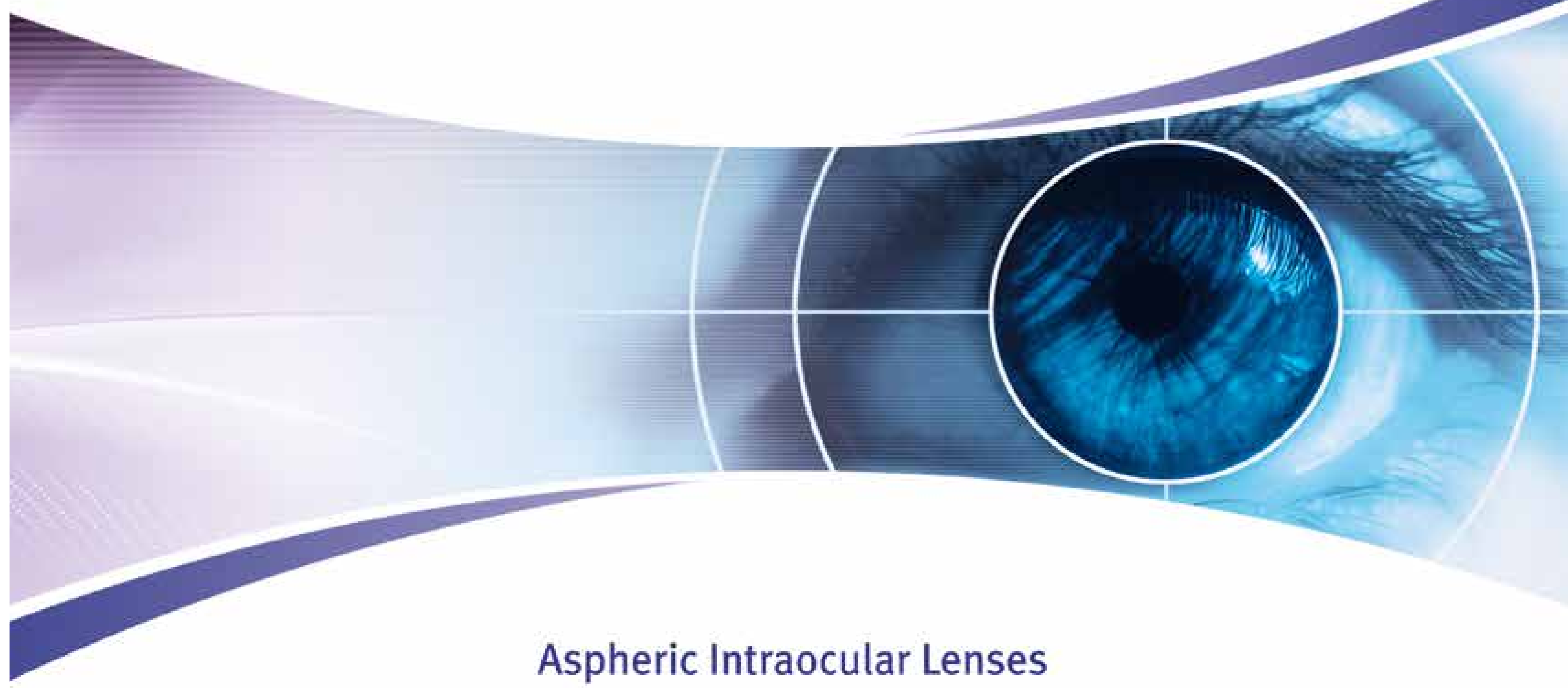
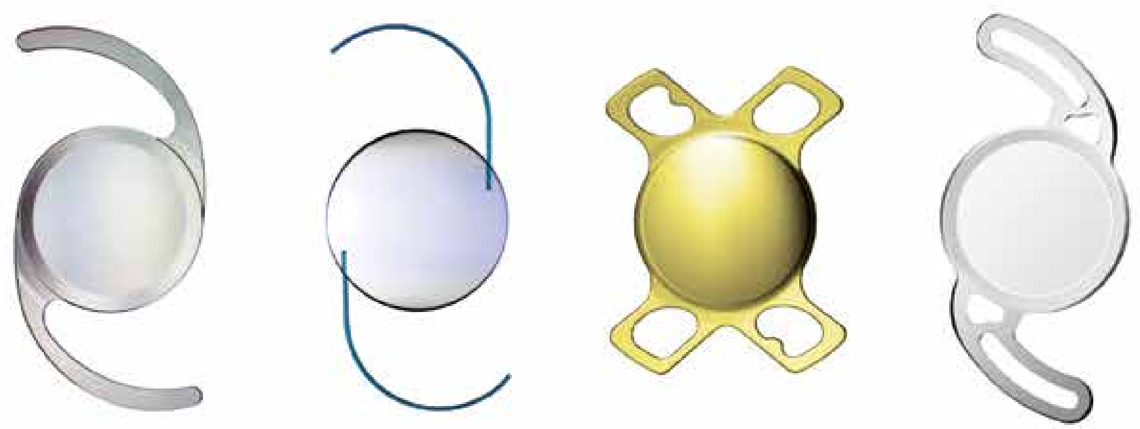


Aspheric Intraocular Lenses



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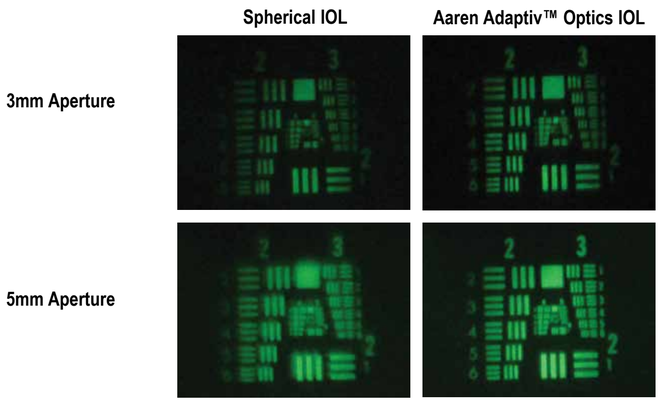
Summary of Benefits

- Improved image quality and contrast sensitivity, specifically in low light conditions.
- Superior depth of focus.
- Unlike first generation aspheric IOLs, consistent results may be expected even in cases of clinically occurring lens decentration or tilt, as shown by wavefront analysis...

Spherical IOLs are subject to aberrations that result in slightly distorted images on the retina - particularly at large pupil diameters. This is because light rays that enter the eye peripherally undergo stronger refraction than those that enter centrally. One of the benefits of Aaren Scientific Adaptiv™ Optics is improved contrast sensitivity especially in low light (large pupil) conditions, as shown in these actual "through lens" photos taken through an eye model:



Best focus position is defined at 3 mm pupil (photopic condition) and maintained at 5 mm pupil testing (scotopic condition).

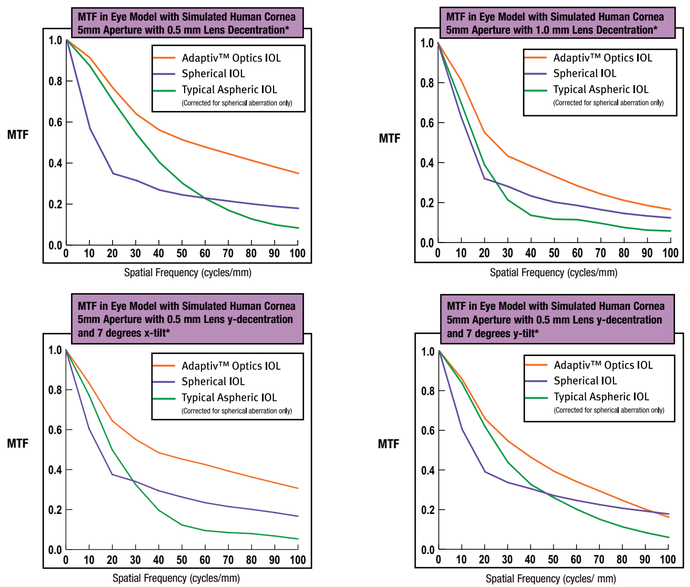
Aspheric IOLs: The Next Generation

One type of 1ST GENERATION aspheric IOL is designed with a prolate aspheric surface to compensate for corneal aberrations when the lens is centered. Because the optics of these lenses are optimized for a centered position, they can perform poorly if they become decentered or tilted - often to the point of performing worse than a spherical lens under the same degree of decentration.

Unfortunately, clinically occurring lens decentration and tilt are common occurrences. Even the typical human eye itself, is not optically symmetrical. Aaren Scientific recognizes this, and has designed Adaptiv™ Optics to represent the NEXT GENERATION of aspheric lenses. Adaptiv Optic design takes into account a broad range of aberrations arising with lens misalignment. Its aspheric surface is non-prolate which physically distinquishes its shape from 1st generation aspherics. Consequently, Aaren's Adaptiv Optics enables better image quality under a variety of real world conditions.

MTF (Modulation Transfer Function) analysis shows the significantly improved image quality of an Aaren aspheric Adaptiv Optics lens to a typical aspheric lens, under various degrees of decentration and tilt. In addition, the MTF of an Adaptiv Optics IOL is comparable to or better than that of a spherical optic in cases of significant lens decentration and tilt.

(100 cycles/mm is equivalent to 20/20 vision)

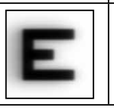


* Best focus defined at 3mm aperture prior to determining MTF at 5mm.

Is Total Residual Spherical Aberration the most important factor in choosing an aspheric lens?

LENS	Spherical IOL	Adaptiv™Optics	Competitor 1	Competitor 2	Competitor 3
Average Corneal SA	+0.27	+0.27	+0.27	+0.27	+0.27
Lens SA	+0.15	-0.12	-0.27	-0.17	0.0
Total Residual SA (for a centered lens)	+0.42	+0.15	0.00	+0.10	+0.27

The answer is not as clear as one might think...

LENS	Spherical IOL	Adaptiv™Optics	Competitor 1	Competitor 2	Competitor 3
20/20 Decentered by 0.5 mm					
20/20 Decentered by 1.0 mm					
20/20 5° tilt					

Images simulated from theoretical analysis using Zemax® software.

Regardless of lens spherical aberration, the optics of 1st generation aspheric IOLs are optimized for the centered position. Because of this some perform poorly if they become decentered or tilted - often to the point of performing worse than a spherical lens under the same conditions. And unfortunately, very few IOLs are perfectly centered in the eye.

Aaren Scientific recognizes this and designed Adaptiv™ Optics with more than just perfect conditions in mind. This optic design takes into account a broad range of aberrations arising with lens misalignment. Adaptiv Optics are also optimized for the range of corneal asphericity to offer benefits for patients of different corneal shapes. Consequently, Aaren's Adaptiv Optics enable better image quality under real world conditions.