Toric Multifocal IOL to Achieve Emmetropia and Near Vision: Three Years Results

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Financial Disclosure
Dr Piovella has the following financial interests or relationships to disclose.
As consultant:
- Abbott Medical Optics
- Aaren Scientific
- Carl Zeiss Meditec

As lectures fees:
- BVI Beaver Visitec International
- Ocular Therapeutix
- TearScience

Dr Kusa has no financial interests or relationships to disclose

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Visual Quality

Effect of Contrast Reduction

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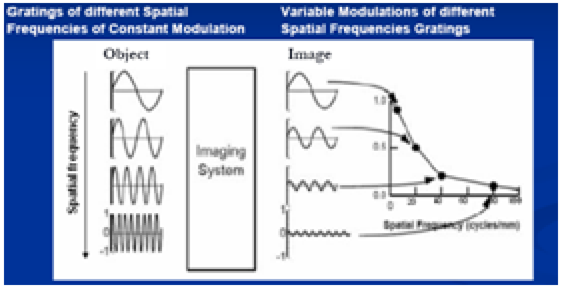
In-focus Image Quality Characterization

How to combine different image dimensions and corresponding contrasts into a single characteristic?



Modulation Transfer Function (MTF) = modulations at the image plane as a function of spatial frequency

MTF is quantitative measure of the ability of Optical System to reproduce Contrast of original object by its image

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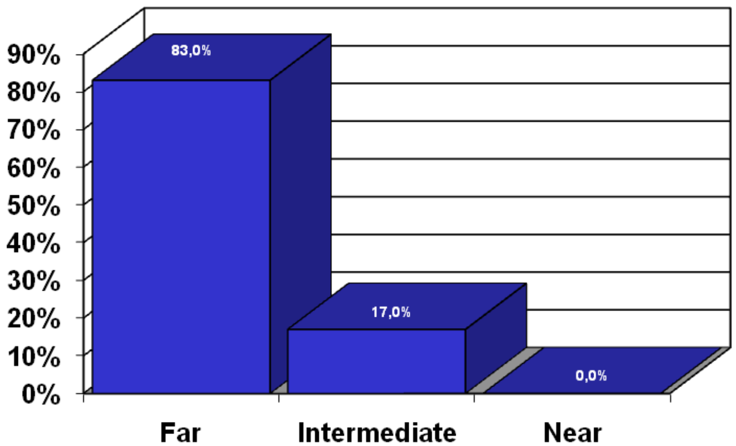
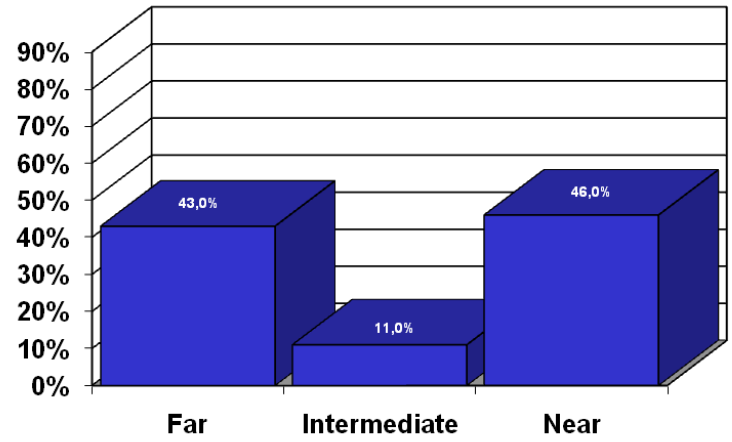
Multifocal IOLs and % Light Distribution (Refractive MIOL Technology)

All multifocal IOLs provide adequate performance for Far and Near distances at nominal 3 mm pupil and differences can be shown towards the limits of the pupil range: 2 mm and 5 mm

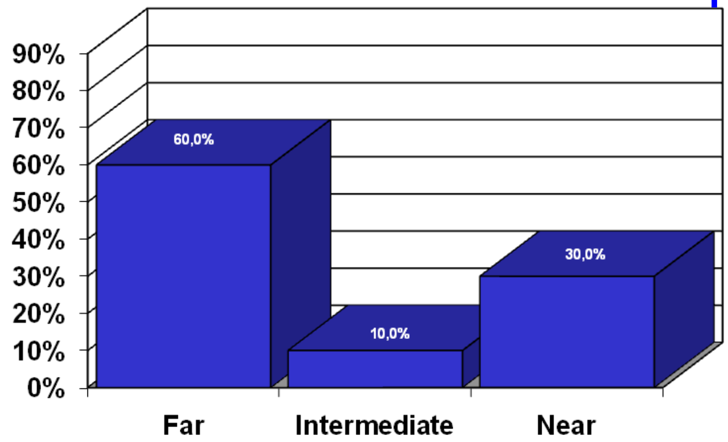


Refractive IOLs and % Light Distribution Pupil Size 2 mm



Refractive IOLs and % Light Distribution Pupil Size 3 mm

Sources: IOL data are from the FDA submission for the optic profile.



Ligh Refractive IOLs and % Light Distribution Pupil Size 5 mm

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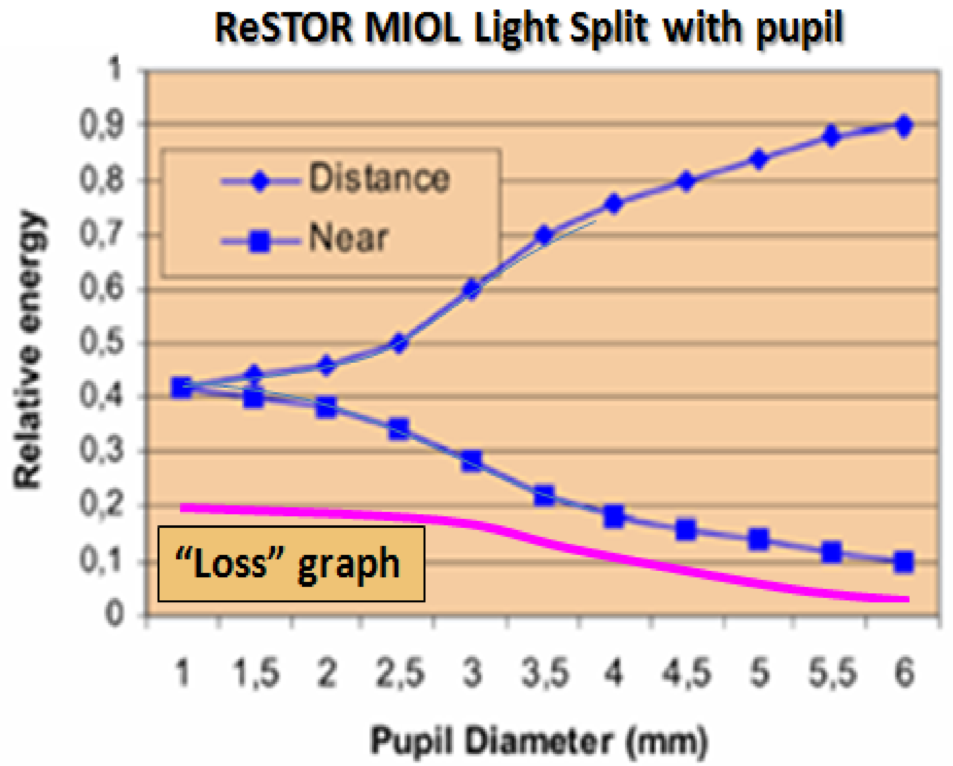
Diffractive MIOL : ReSTOR™ (Alcon)

Diffraction Efficiency : % Light Distribution and Light Loss

Light Loss" graph is absolute light energy; Far and Near graphs are relative values.



Advantages

- Distance Dominant
- Diffractive Optics allow for Far and Near vision
- Apodized diffractive design to reduce halos

Disadvantages

- May not have sufficient Near at large pupils
- No provision for intermediate focus
- Substantial percent of light is outside range of vision for small to medium pupils

	% LIGHT DISTRIBUTION			LIGHT "LOSS"
	Near	Intermediate	Far	Outside Range of Vision
2 mm pupil	40%	0%	40%	20%
5 mm pupil	10%	0%	84%	6%

Diffractive MIOL - AcriLisa® (Zeiss)
Diffraction Efficiency: % Light Distribution and Light Loss

- Anterior Diffractive Bifocal Surface with 2.8 D Effective Add Power
- Prolate Aspheric posterior Surface to improve image Contrast
- Diffractive MIOL doesn't have Provision for Intermediate Focus

Advantages

- Distance Dominant
- Diffractive Optics allow for Distance and Near Vision for full range of pupils
- Refractive phase sub-zones allow to increase light use for imaging vs balze sharp Diffractive MIOL

Disadvantages

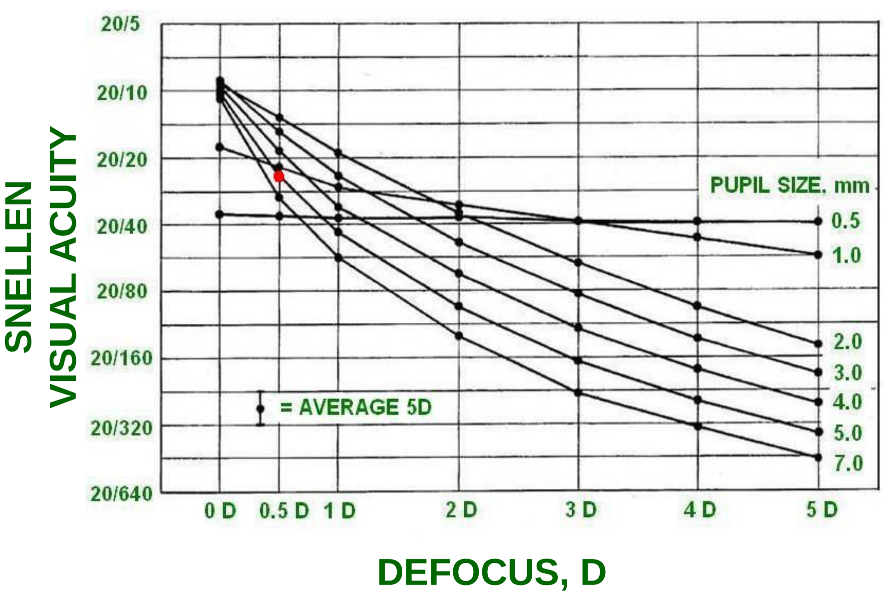
- No provision for intermediate vision
- Significant percent of light is still outside range of vision

% LIGHT DISTRIBUTION				LIGHT "LOSS"
	Near	Intermediate	Far	Outside Range of Vision
2 mm pupil	30%	0%	55%	15%
5 mm pupil	30%	0%	55%	15%

Residual Refractive Error as Function of Pupil Size and Defocus

Monofocal Technology Visual Acuity Sensitivity to Residual Refractive Error as Function of Pupil Size (Patent of Jack Holladay)

Visual Acuity (20/24) with 0.50 D Defocus and 5mm Pupil Size



Monofocal Technology Snellen Visual Acuity as Function of Pupil Size and Defocus (Patent of Jack Holladay)

Pupil size

Diopters	2.0	3.0	4.0	5.0	6.0	7.0
TDL	20/09	20/06	20/04	20/04	20/03	20/03
0.0	20/10	20/09	20/10	20/10	20/11	20/11
0.50	20/12	20/15	20/19	20/24	20/28	20/30
1.00	20/19	20/24	20/33	20/44	20/52	20/56
2.00	20/36	20/49	20/68	20/95	20/121	20/130

TDL indicates Theoretical Diffraction Limits

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Diffractive Technology
Snellen Visual Acuity as Function of Pupil Size and Defocus

- **In Multifocal lenses, VA sensitivity to refractive error depends on a multifocal design.**
- **In a diffractive MIOL the effect of refractive error was about twice more sensitive to than in case of a monofocal IOL : postoperative refractive result of -0,50 sf is equivalent to the total aberrations amount of -1 sf with MIOL.**
- **Toric vs. spherical it is two times difference: the effect of 1 D cylinder error on VA is about 0.5 D spherical refractive error**

Weak Points of Diffractive Multifocal IOLs

- **Reduction of Contrast Sensitivity (up to 30%)**
- **Diffraction Grooves(Blaze hight) Creates Different Diffraction Efficiency and Light Loss**
- **Toric Multifocal when 0,75 D of Corneal Astigmatism**
- **Healos, Glare and Ghost Images are Difficult to Manage in Suspicious Patients**
- **Poor Intermediate Distance Vision**
- **0.50 Diopter SE generates loss of more than one line of Visual Acuity**
- **Perfect Target: Plano Postop Refractive Results**

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Acri.LISA Toric® Study
Materials and Methods

Acri.LISA® MIOL implanted in 35 eyes of 22 patients

Mean age: 61.80 ± 14.04 years.
Follow-up: 3 years

- **Best corrected distance VA (BCVA) Distance**
- **Post-op Mean Refractive Astigmatism**
- **Post-op Sphere Equivalent**
- **Binocular Near VA**

Pre-op Mean Corneal Astigmatism 1.63 D

Pre-op Mean Refractive Astigmatism 1.25 D

Mean IOL Astigmastism 1.66 D

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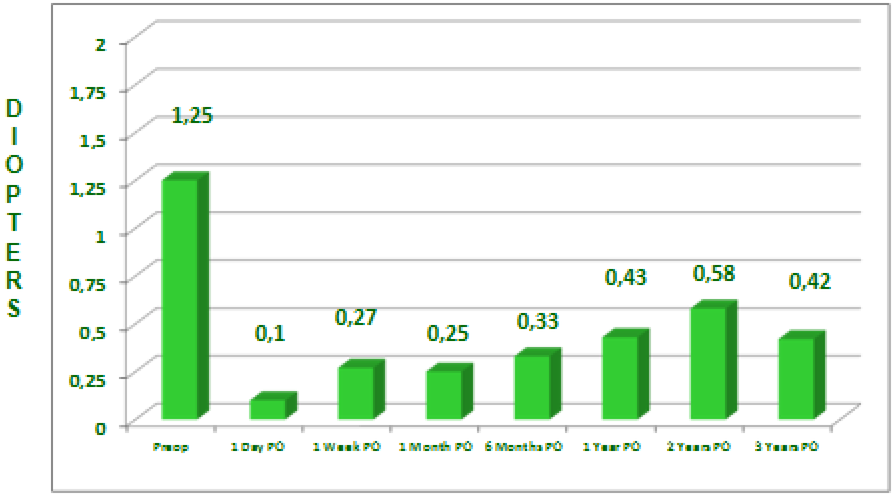
Acri.LISA® Toric
Post-op Mean Refractive Astigmatism (35 Eyes)
(Pre-op Mean Corneal Astigmatism 1.63 D)



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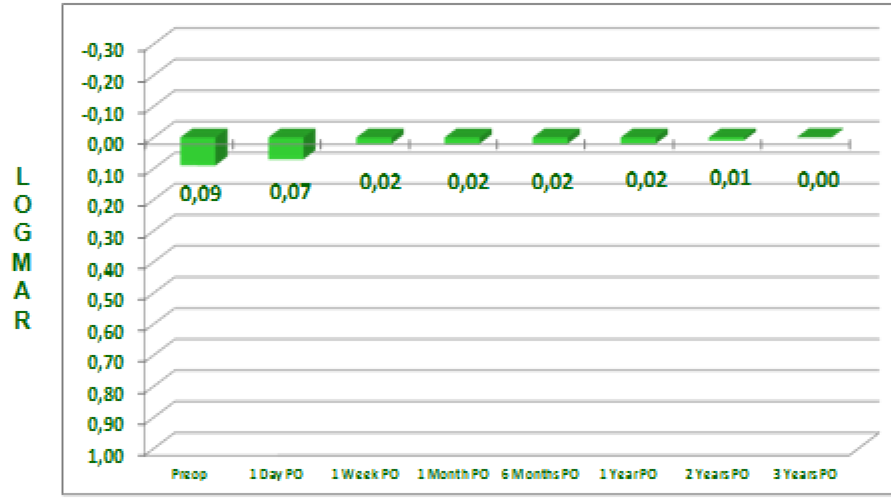
Acri.LISA® Toric
BCVA (35 Eyes)



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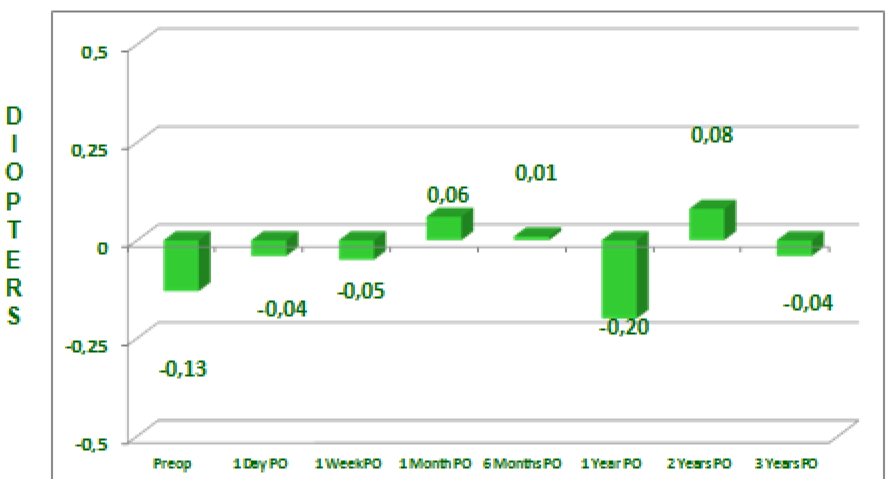
Acri.LISA® Toric
Sphere Equivalent (35 Eyes)



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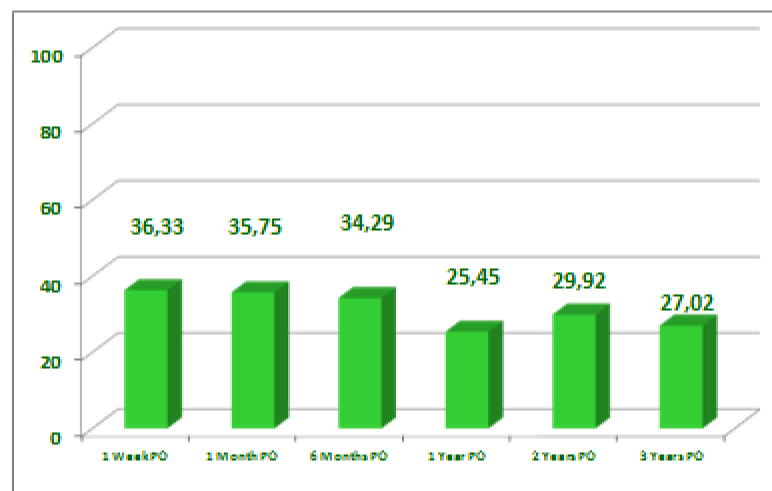
Acri.LISA® Toric
Near Vision (EDTRS) (35 Eyes)



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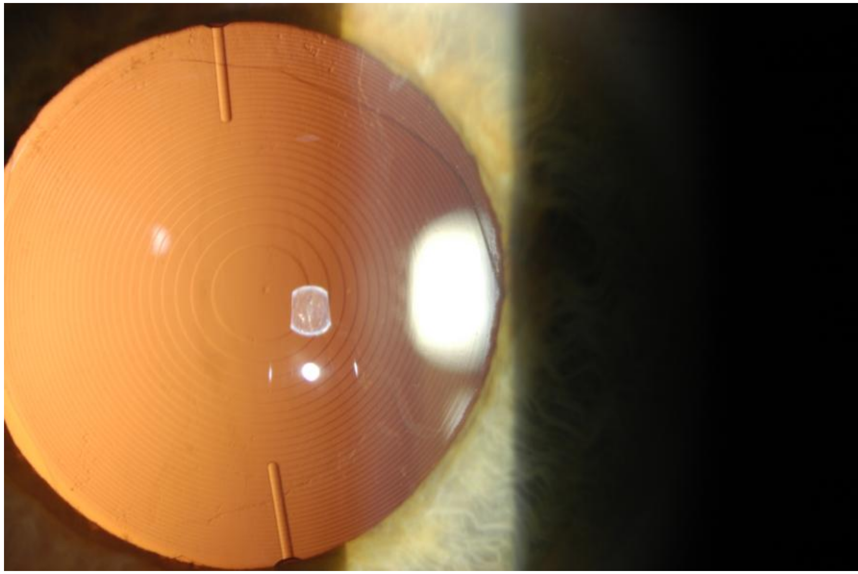
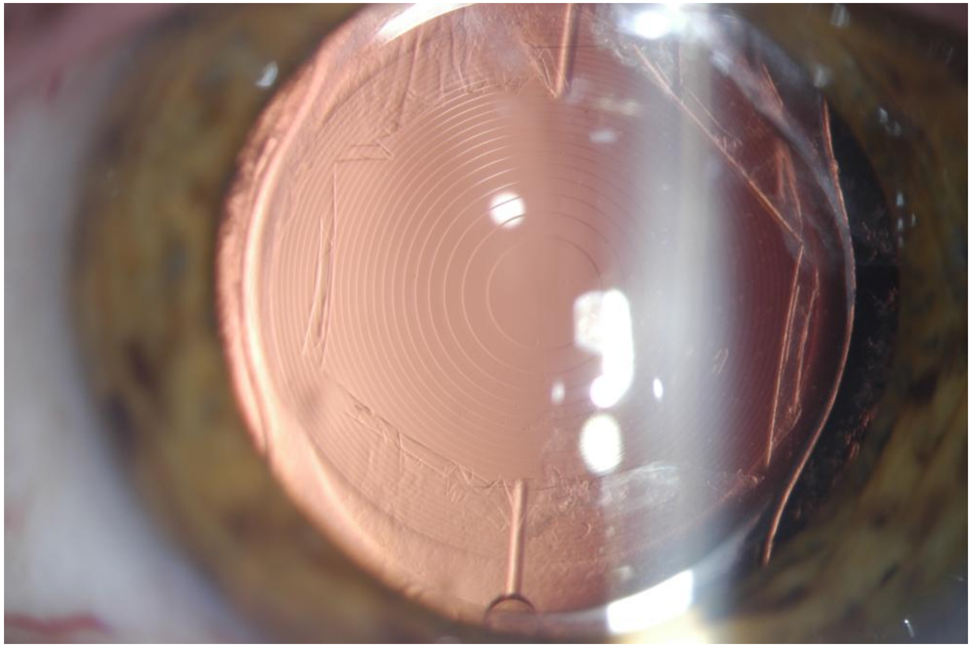
Acri.LISA®Toric
% YAG LASER CAPSULOTOMY - 35 EYES



EARLY YAG LASER TREATMENTS (within one year postop)

12 Eyes : yag laser treatments **(34.2%**)



Quality of Vision
Contrast Sensitivity and Control Values

Control values for CS are derived from Hohberger paper

B. Hohberger et al. "Measuring contrast sensitivity in normal subjects with OPTEC® 6500: influence of age and glare" Graefes Arch Clin Exp Ophthalmol, 2007; 245:1805-1814

- **10-14 healthy phakic subjects for the following age groups**
  <30; 30-39;40-49;50-59;≥60
- **Functional Image Analyzer OPTEC 6500P**
- **Daytime (85 cd/m^2), Nighttime (3 cd/m^2)and**
  Nighttime with Glare(3 cd/m^2)
- **Monocular testing**
- **Paper demonstrated strong age dependence of C S with age**

1. Forehead Activator
2. Headrest Tissue Holder
3. Lens System
4. Instrument Base
5. Elevation Adjustment
6. Observation Door
7. Far and Near Indicators
8. Test Dial & Knob
9. Receptacle for power cord and control panel
10. Instrument Body
11. Carrying Handle
12. Ancillary Lens Holder
13. On/Off Button

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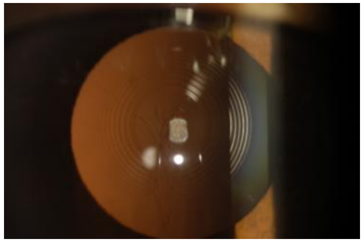
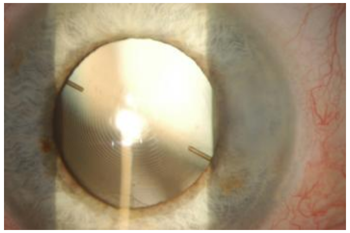
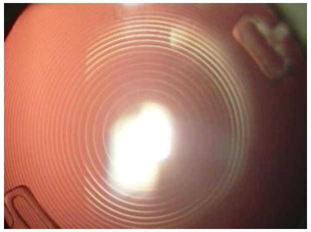
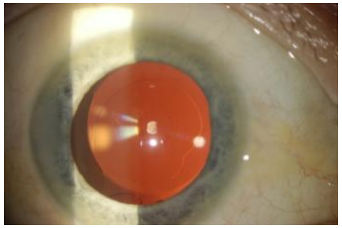
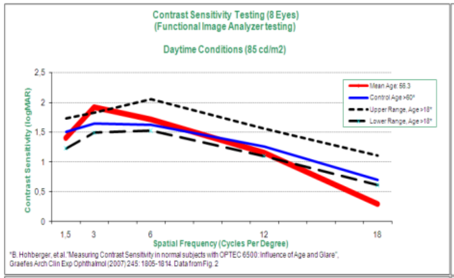
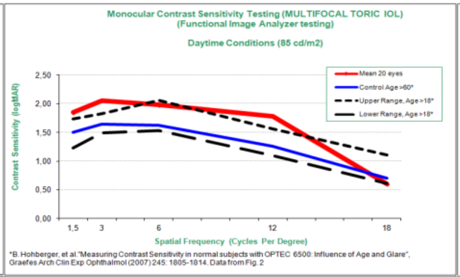
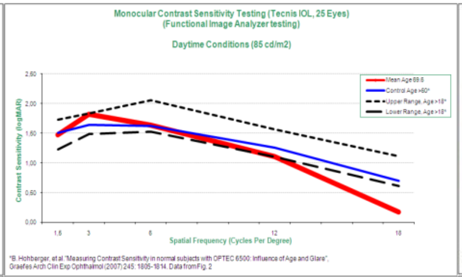
Multifocal IOLs Contrast Sensitivity

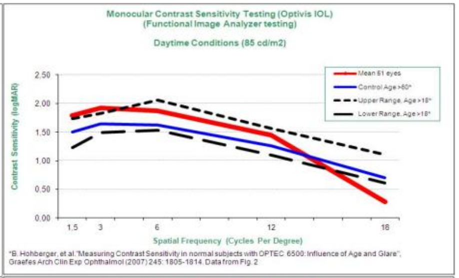
Acri.LISA ®	Acri.LISA ® Toric	Tecnis ®	Optivis ®

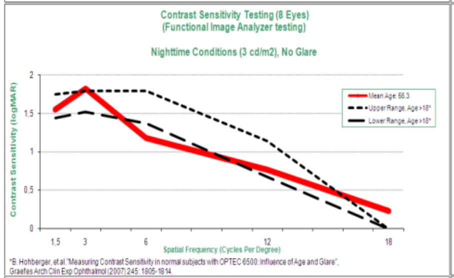





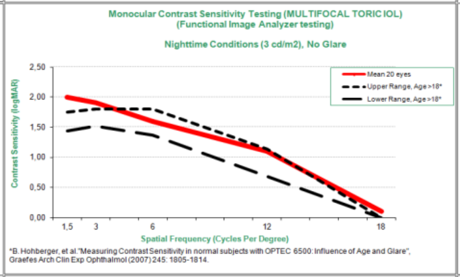


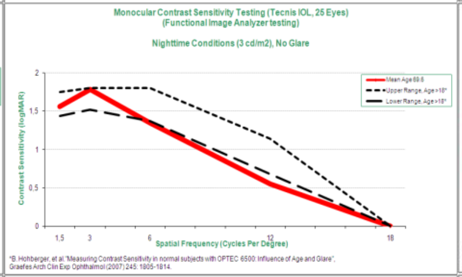


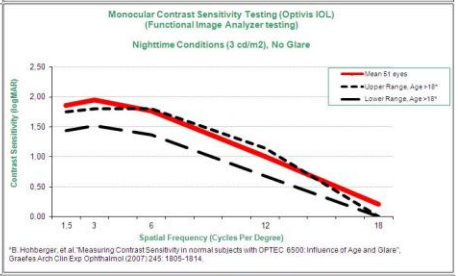


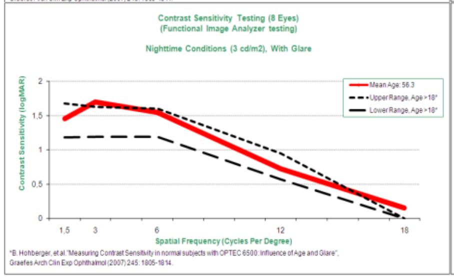


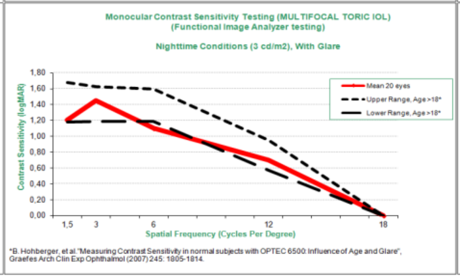


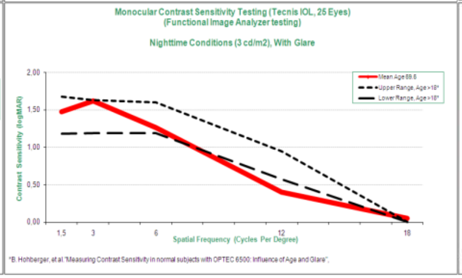


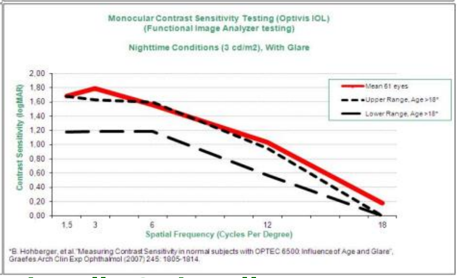












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