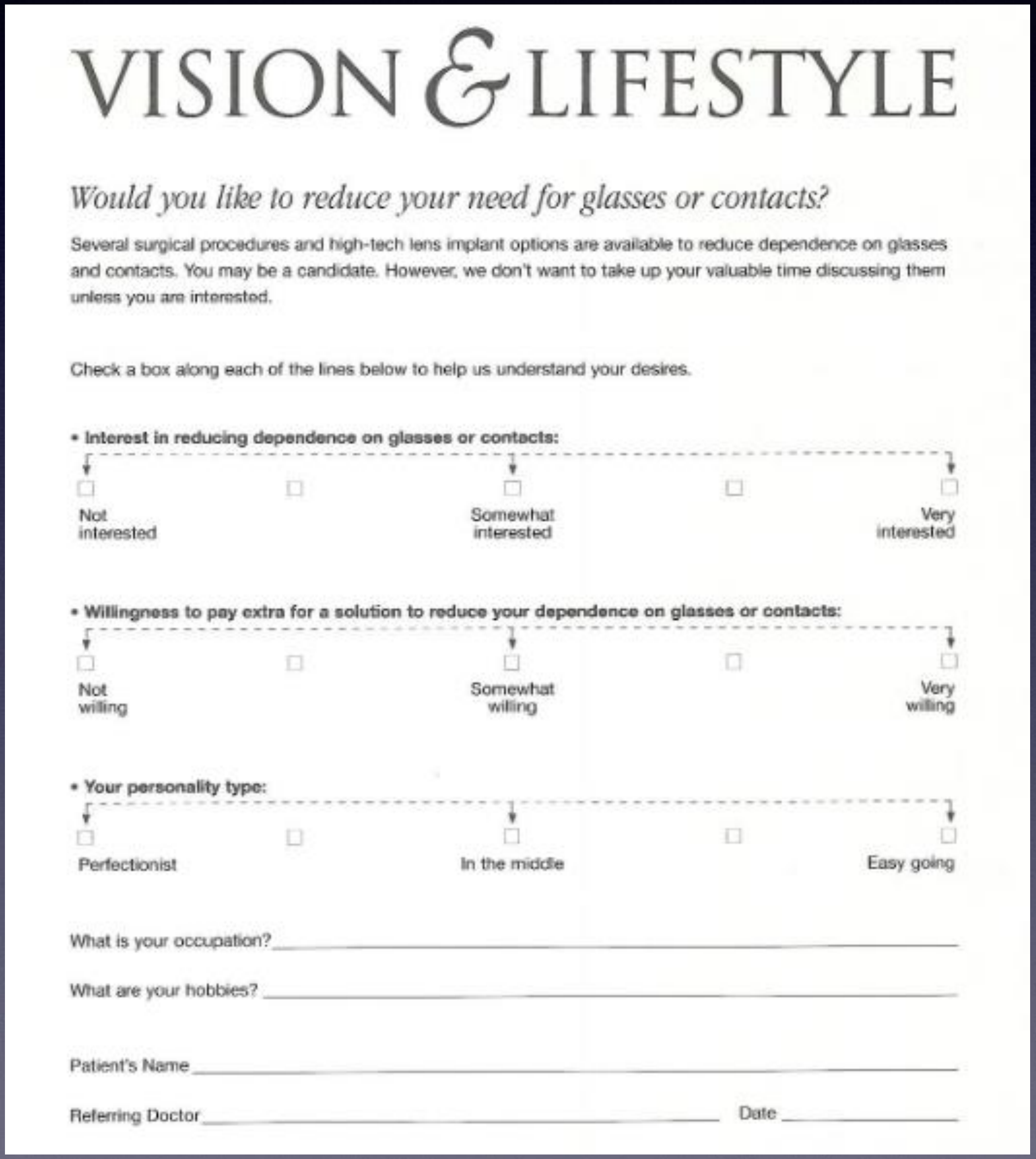
Cataract Surgery in the (not so distant) Future

Alan C. Parent, MD, FACS

Currently the refractive outcome following cataract surgery is determined by extensive PRE-operative work

PRE-op

- Patient questioneers
- Patient interviews



VISION & LIFESTYLE

Would you like to reduce your need for glasses or contacts?

Several surgical procedures and high-tech lens implant options are available to reduce dependence on glasses and contacts. You may be a candidate. However, we don't want to take up your valuable time discussing them unless you are interested.

Check a box along each of the lines below to help us understand your desires.

- **Interest in reducing dependence on glasses or contacts:**

☐ Not interested ☐ ☐ Somewhat interested ☐ ☐ Very interested

- **Willingness to pay extra for a solution to reduce your dependence on glasses or contacts:**

☐ Not willing ☐ ☐ Somewhat willing ☐ ☐ Very willing

- **Your personality type:**

☐ Perfectionist ☐ ☐ In the middle ☐ ☐ Easy going

What is your occupation? ______

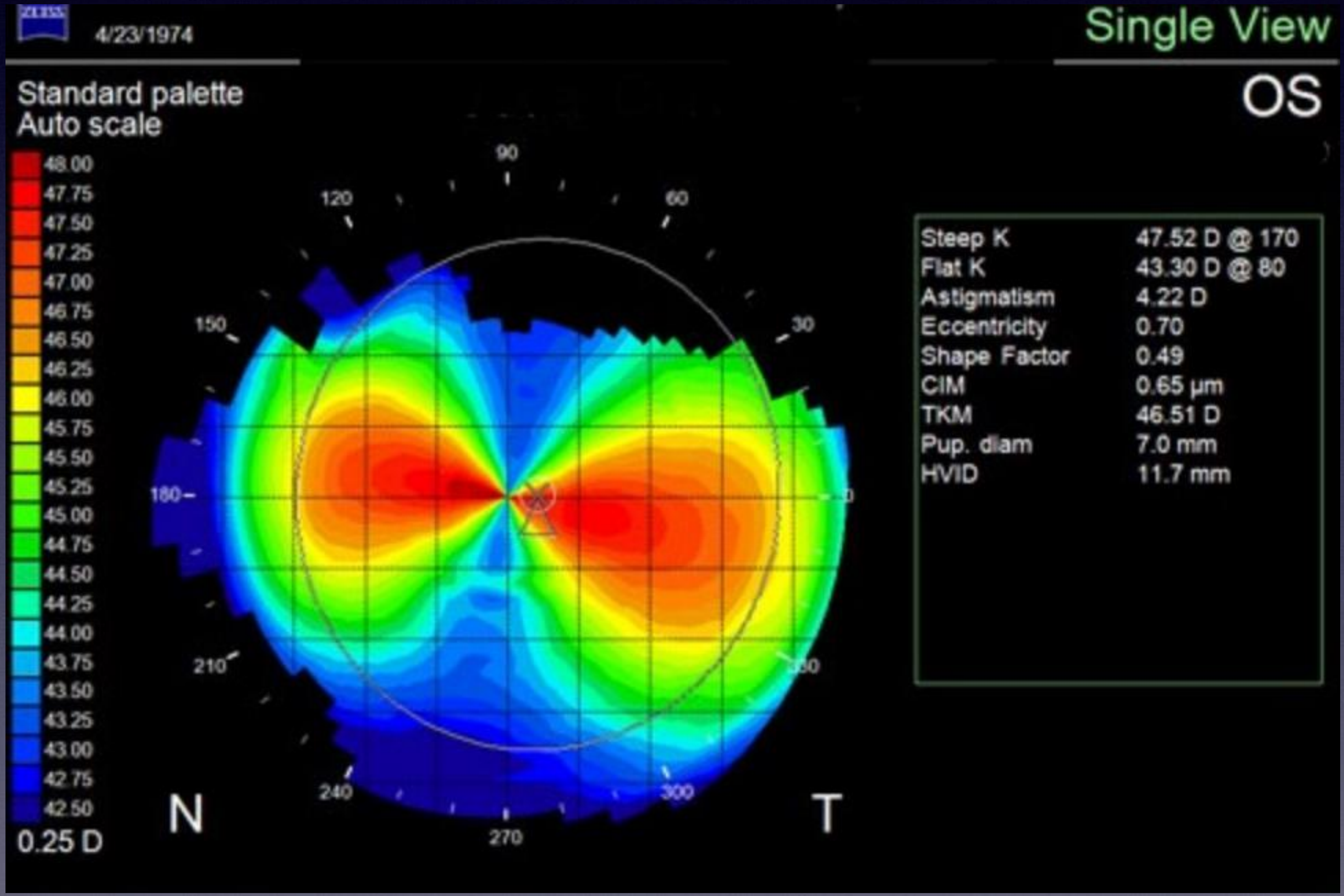
What are your hobbies? ______

Patient's Name ______

Referring Doctor ______ Date ______

PRE-op testing

- Refraction
- Keratometry
- topography
- biometry



IOL formulas and calculations

- SRK-T
- Holliday 1 and 2
- Hoffer
- Haigis
- Optomization

OD right

AL: 24.17 mm (SNR = 87.6)
K1: 44.53 D / 7.58 mm @ 123°
K2: 45.06 D / 7.49 mm @ 33°
R / SE: 7.54 mm (SD = 44.80 mm)
Cyl.: -0.53 D @ 123°
opt. ACD: 3.69 mm

Eye Status: phakic

SRK®/T		Haigis	
A Const:	119	A0 Const:	-0.523
		A1 Const:	0.172
		A2 Const:	0.211
IOL (D)	REF (D)	IOL (D)	REF (D)
19.5	-1.09	19.0	-1.15
19.0	-0.76	18.5	-0.79
18.5	-0.43	18.0	-0.44
18.0	**-0.11**	**17.5**	**-0.10**
17.5	0.21	17.0	0.25
17.0	0.52	16.5	0.59
16.5	0.84	16.0	0.92
Emme. IOL: 17.83		Emme. IOL: 17.36	

Holladay		HofferQ	
SF:	1.79	pACD Const:	5.58
IOL (D)	REF (D)	IOL (D)	REF (D)
19.0	-0.99	18.5	-0.9
18.5	-0.66	18.0	-0.5
18.0	-0.34	17.5	-0.2
17.5	**-0.01**	**17.0**	**0.1**
17.0	0.31	16.5	0.4
16.5	0.62	16.0	0.7
16.0	0.94	15.5	1.1
Emme. IOL: 17.48		Emme. IOL: 17.17	

OS left

AL: 24.18 mm (SNR = 231.6)
K1: 43.77 D / 7.71 mm @ 80°
K2: 44.64 D / 7.56 mm @ 170°
R / SE: 7.63 mm (SD = 44.20 mm)
Cyl.: -0.87 D @ 80°
opt. ACD: 3.52 mm

Eye Status: phakic

SRK®/T		Haigis	
A Const:	119	A0 Const:	-0.523
		A1 Const:	0.172
		A2 Const:	0.211
IOL (D)	REF (D)	IOL (D)	REF (D)
20.0	-1.03	19.5	-0.97
19.5	-0.70	19.0	-0.62
19.0	-0.37	18.5	-0.27
18.5	**-0.04**	**18.0**	**0.08**
18.0	0.29	17.5	0.42
17.5	0.61	17.0	0.76
17.0	0.92	16.5	1.10
Emme. IOL: 18.44		Emme. IOL: 18.12	

Holladay		HofferQ	
SF:	1.79	pACD Const:	5.58
IOL (D)	REF (D)	IOL (D)	REF (D)
19.5	-0.87	19.5	-1.0
19.0	-0.53	19.0	-0.7
18.5	-0.20	18.5	-0.4
18.0	**0.13**	**18.0**	**0.0**
17.5	0.45	17.5	0.3
17.0	0.77	17.0	0.6
16.5	1.08	16.5	0.9
Emme. IOL: 18.19		Emme. IOL: 17.97	

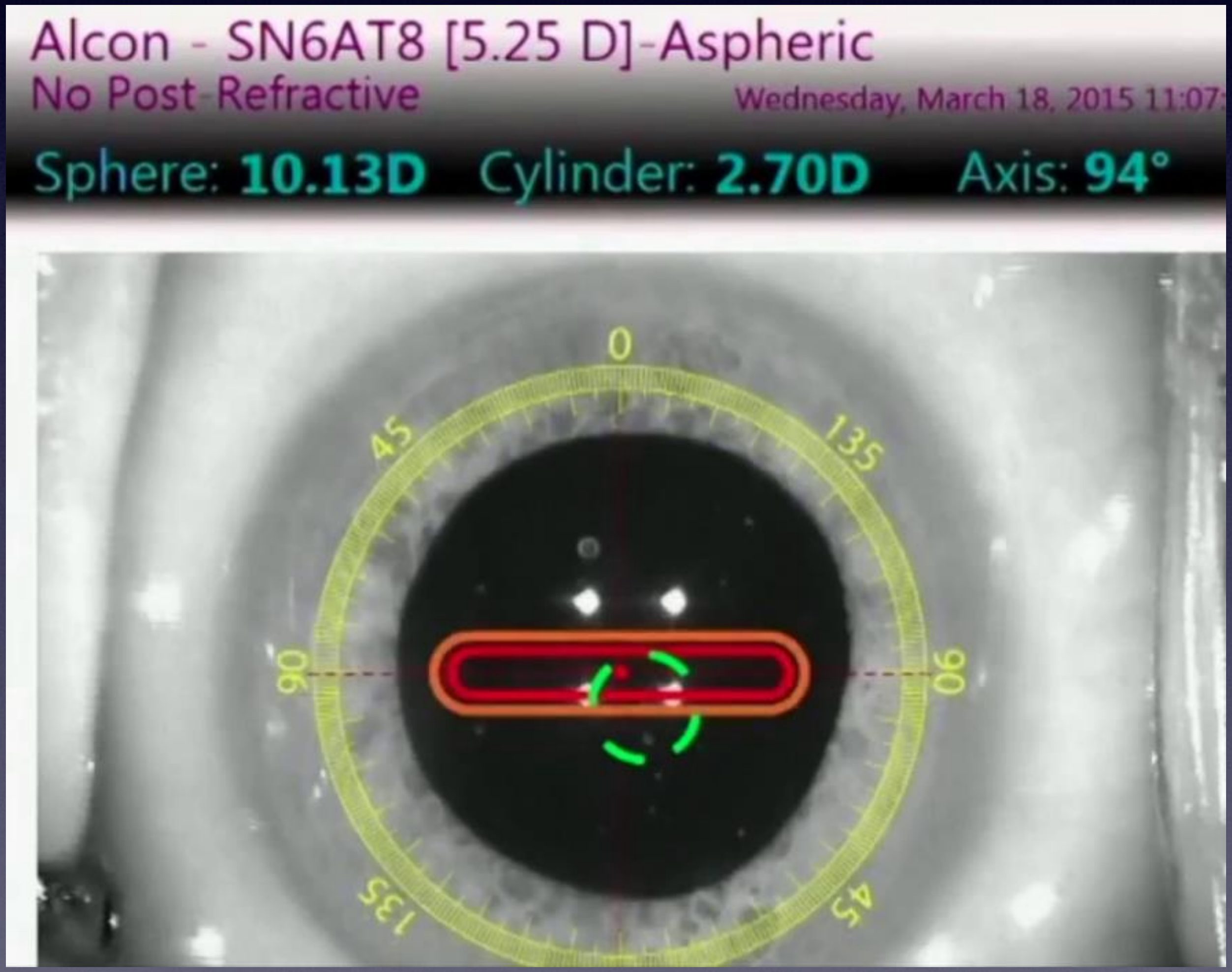
IOL selection

- monofocal
- toric
- multifocal
- multifocal toric
- EDF
- EDF toric
- accommodating

Our cataract patients struggle to understand concepts such as focal point, depth of focus, contrast sensitivity, astigmatism, hyperopia, myopia, and presbyopia

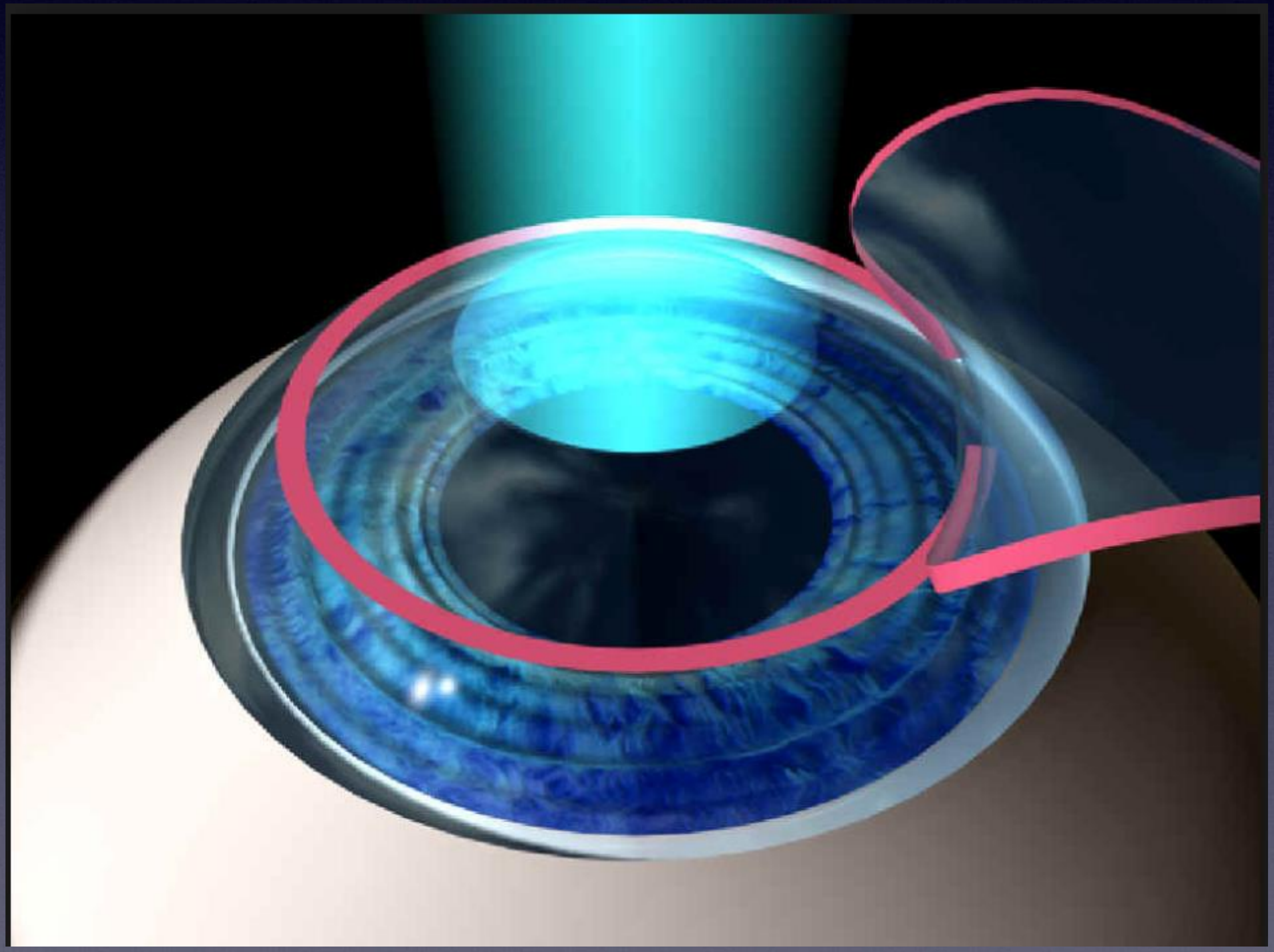
Intra-op adjustments

- eximer laser
- limbal relaxing excisions
- interoperative abberometry



Post-op adjustments

- IOL exchange
- Piggyback IOL
- Refractive surgery (LASIK)



Results

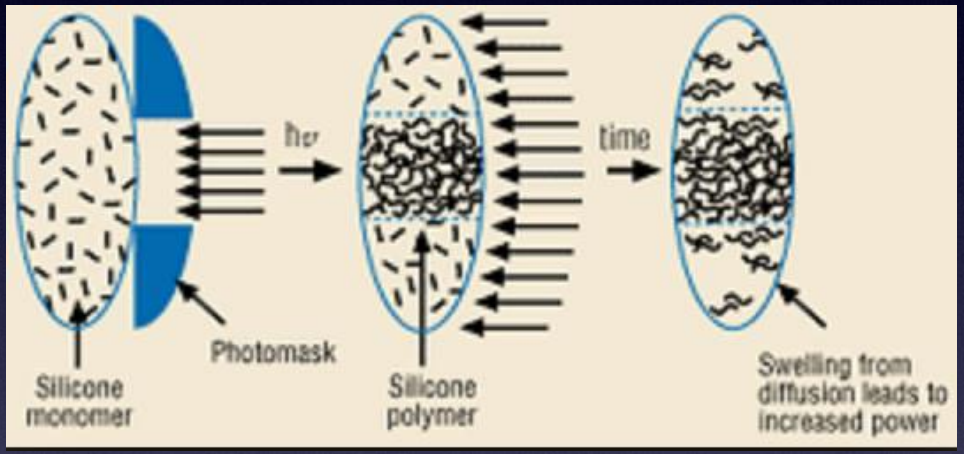
- Best case 80% +/- .5D
- Variability in healing
- PCO
- Patient satisfaction with choice

Ophthalmologists are perplexed by the frequent poor correlation between surgical anatomical success, residual refractive error, and subjective “20/happy” outcomes

So what's the future?

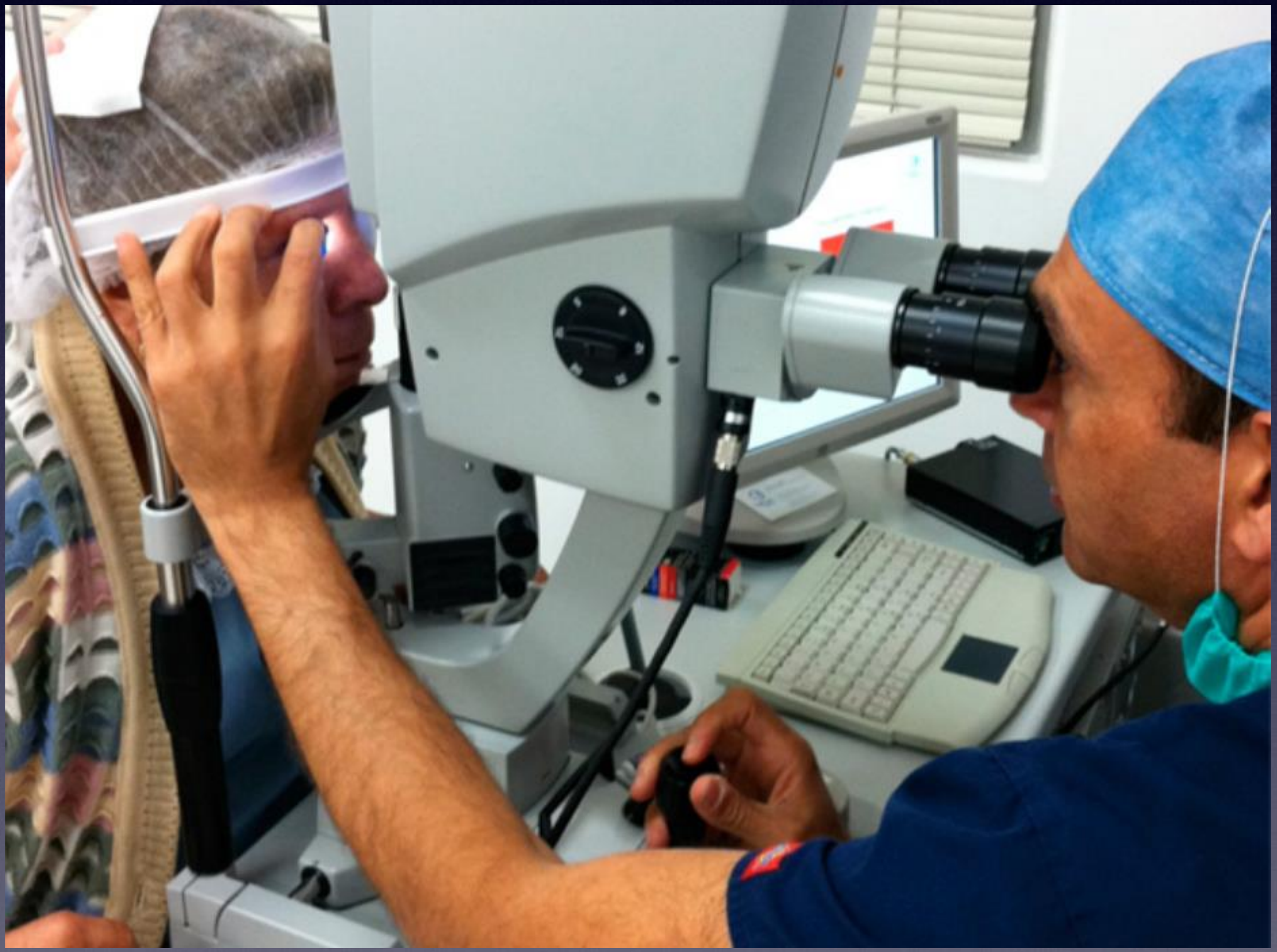
Light Adjustable IOL

- RxSight
- 3-piece
- diffusible, photosensitive silicon macromers



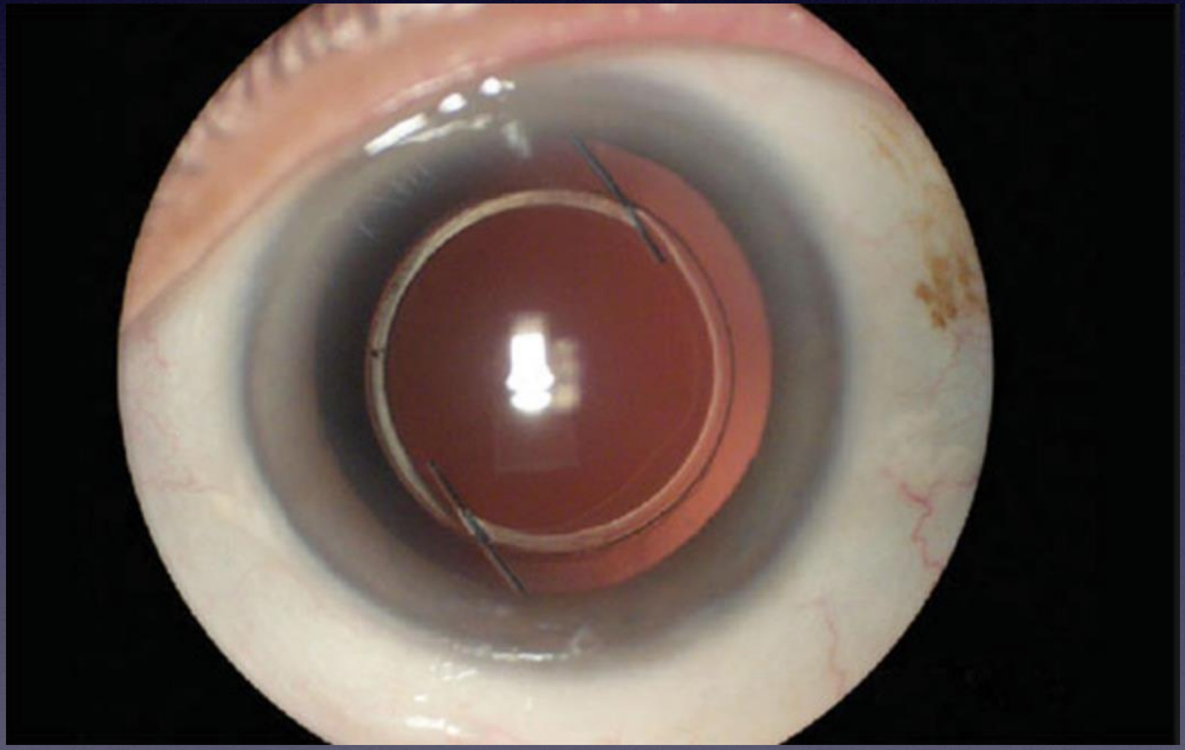
Light Adjustable IOL

- Slit lamp delivery of UV light
- Can be adjusted multiple times before “lock in”
- Sphere and cylinder adjustments

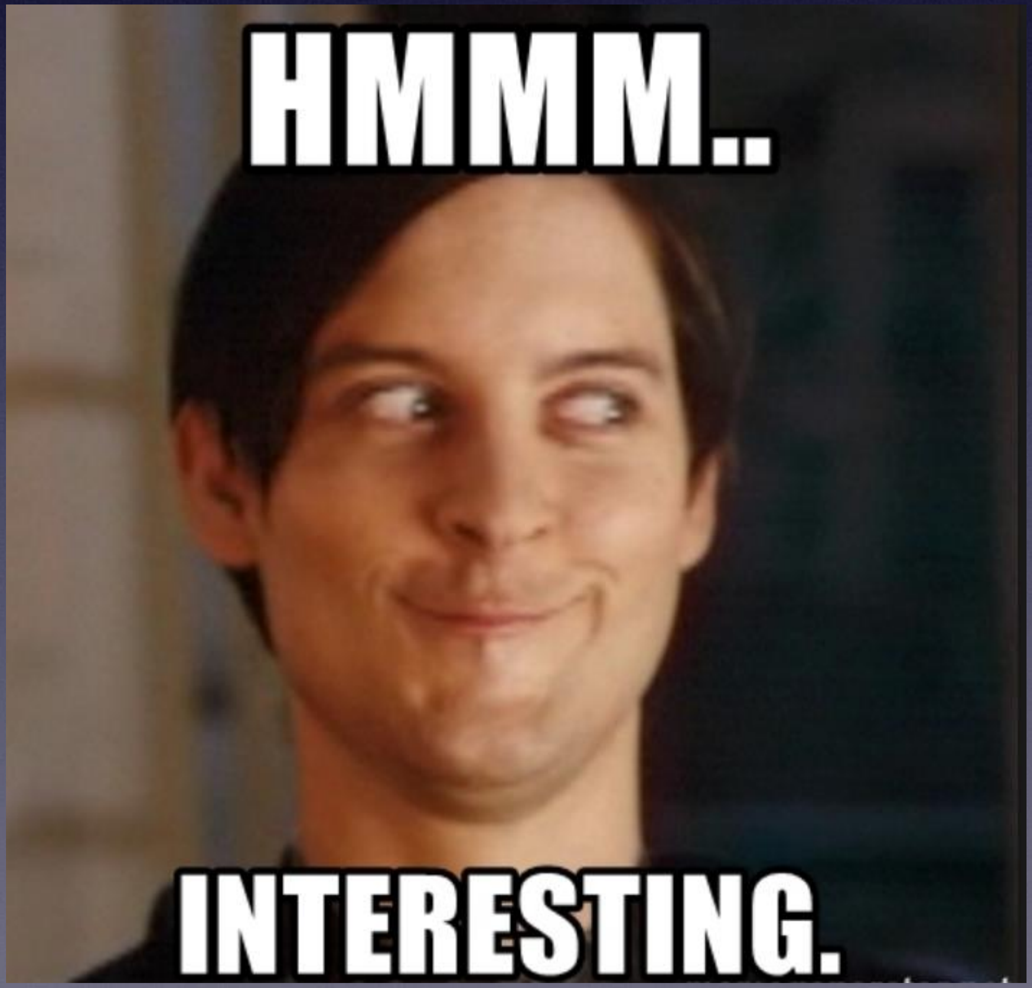


Light Adjustable IOL

- Must wear special glasses prior to lock in
- Once locked no more adjustments
- No multifocal option

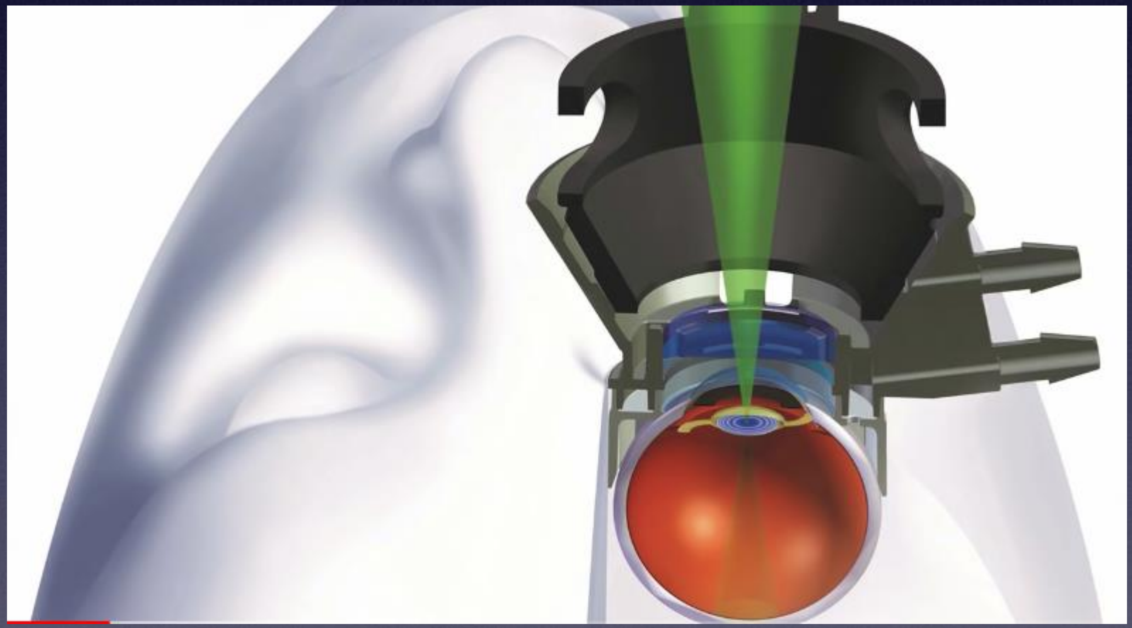


Is there something better??



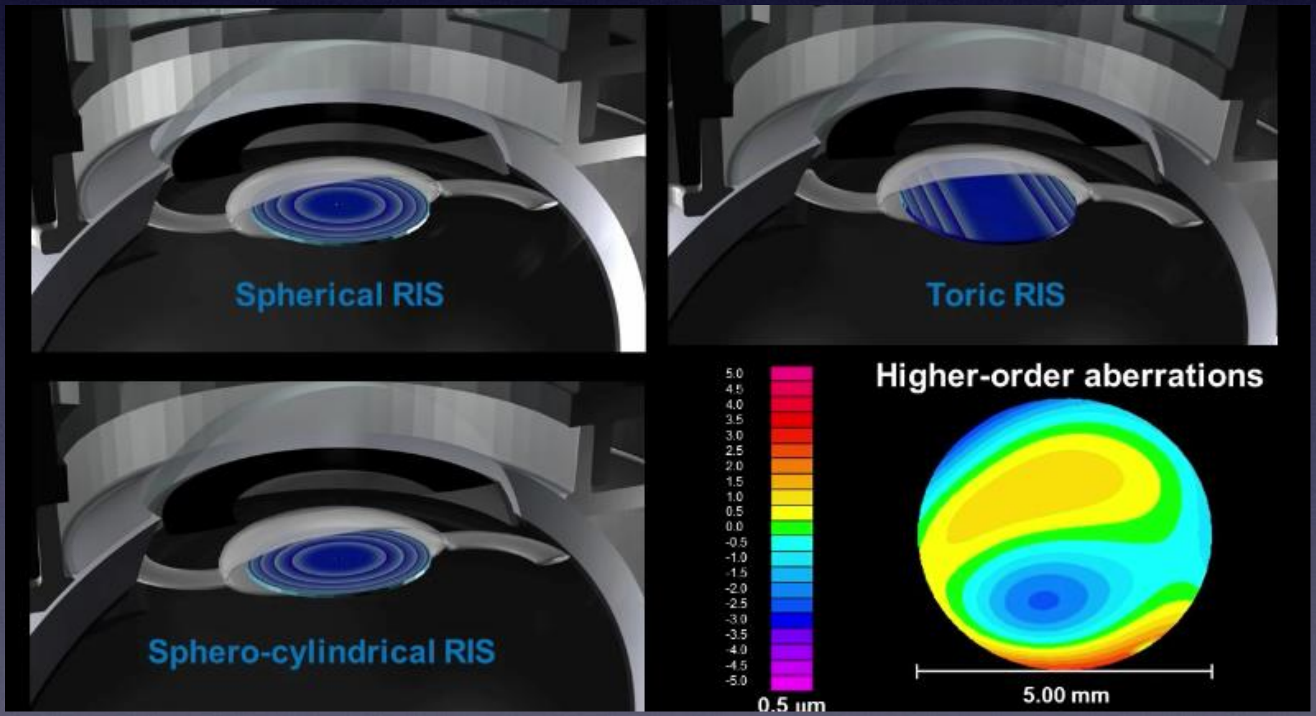
Laser Refractive Index Shaping

- Perfect Lens and Clerio Vision
- Ultrafast femto laser
- 100x less pulse energy

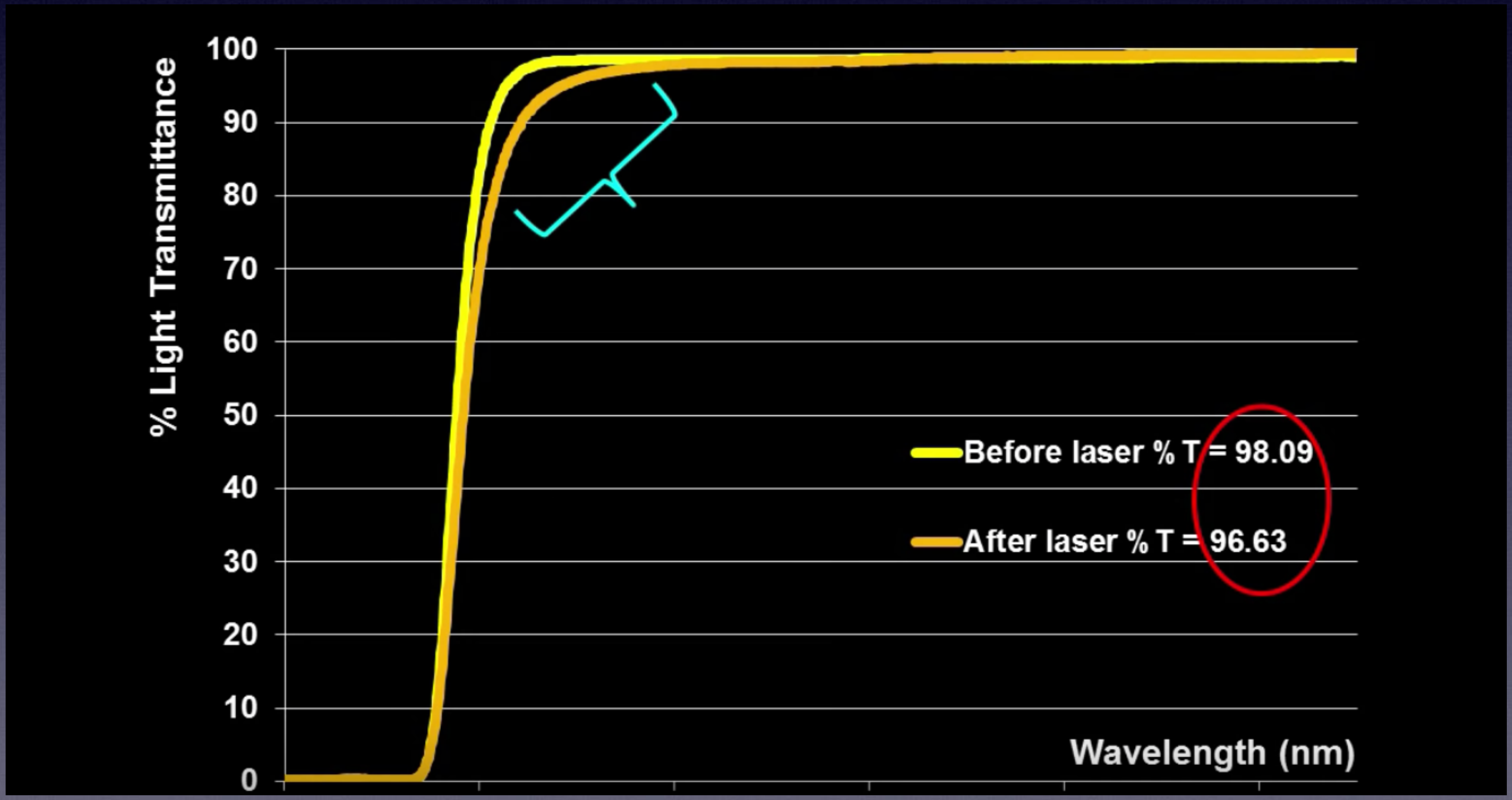


Laser Refractive Index Shaping

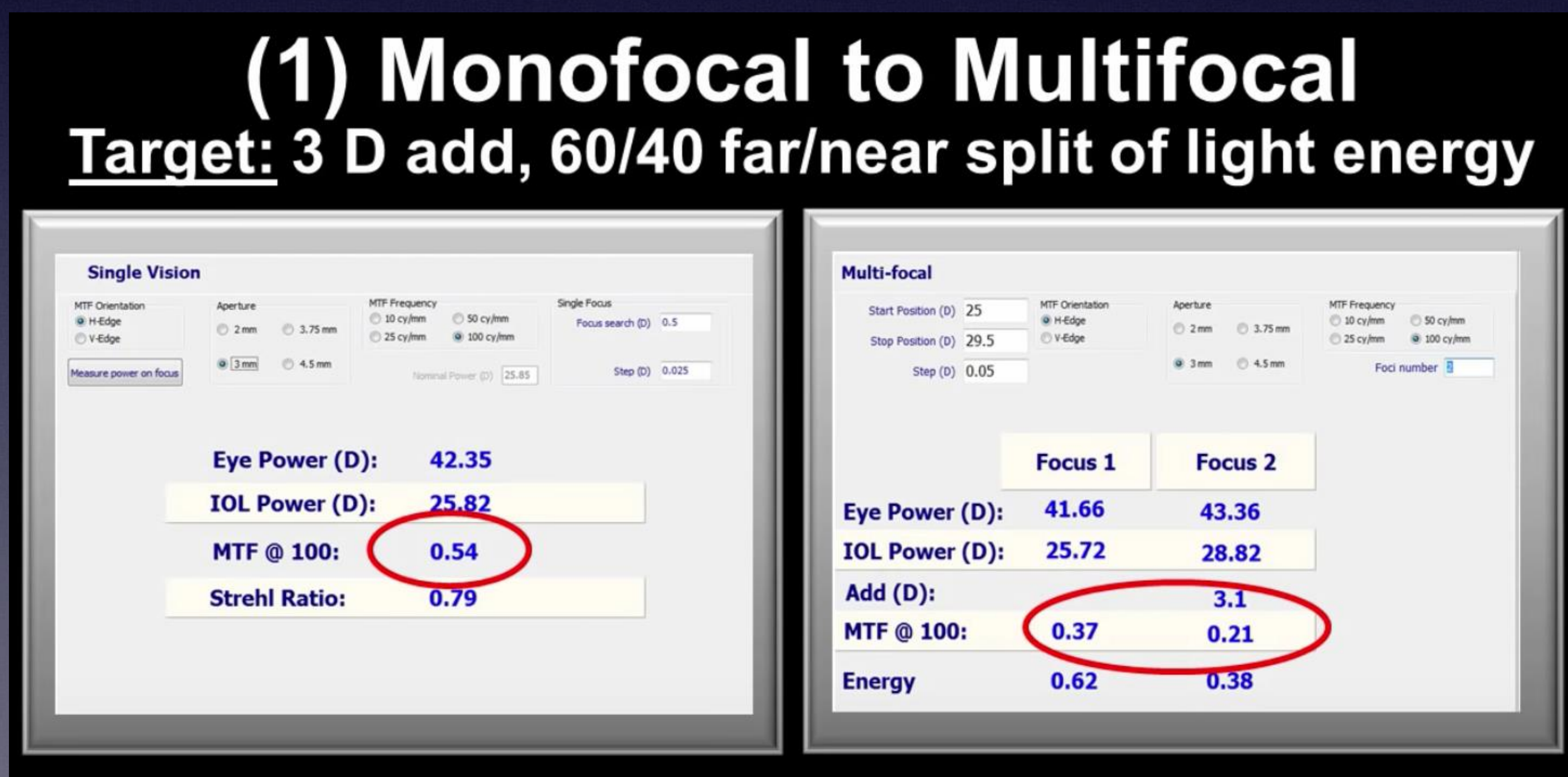
- Fast - 23s to change 3.6D
- Every IOL adjustable
- Sphere and cylinder
- Multifocal option



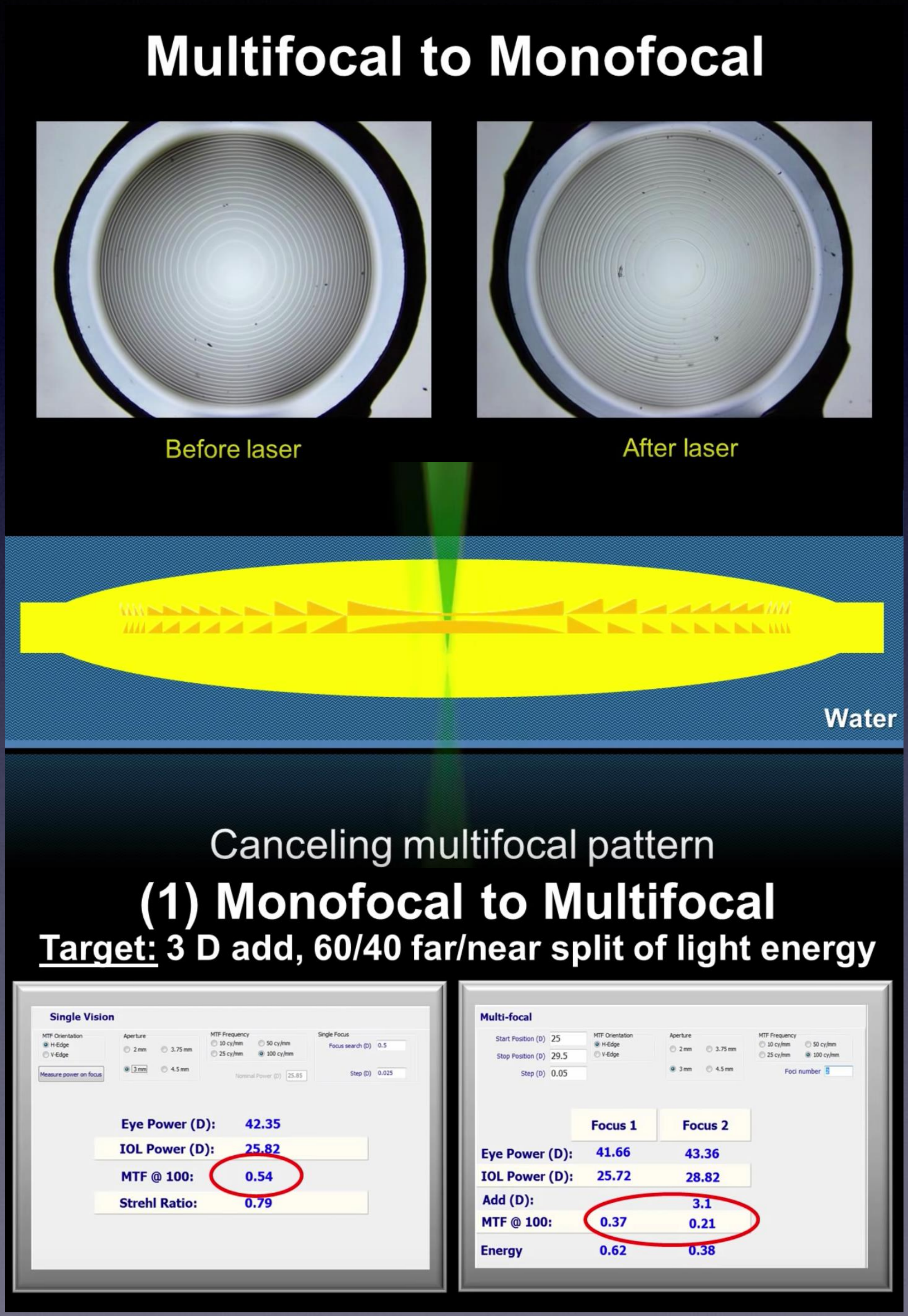
Laser Refractive Index Shaping



Laser Refractive Index Shaping



Laser Refractive Index Shaping



Refractive Index Shaping

- No limit on adjustments
- No special glasses
- Patient decides what
- Give them exact results

Safer and more flexible approach. Offers new vision correction solutions to a broader patient population

LABORATORY SCIENCE

Biocompatibility of intraocular lens power adjustment using a femtosecond laser in a rabbit model

Liliana Werner, MD, PhD, Jason Ludlow, MD, Jason Nguyen, MD, Joah Aliancy, MD, Larry Ha, BS, Bryan Masino, BS, Sean Enright, BS, Ray K. Alley, BS, Ruth Sahler, MSc, Nick Mamalis, MD

Purpose: To evaluate the biocompatibility (uveal and capsular) of intraocular lens (IOL) power adjustment by a femtosecond laser obtained through increased hydrophilicity of targeted areas within the optic, creating the ability to build a refractive-index shaping lens within an existing IOL.

Setting: John A. Moran Eye Center, University of Utah, Salt Lake City, Utah, USA.

Design: Experimental study.

Methods: Six rabbits had phacoemulsification with bilateral implantation of a commercially available hydrophobic acrylic IOL. The postoperative power adjustment was performed 2 weeks after implantation in 1 eye of each rabbit. The animals were followed clinically for an additional 2 weeks and then killed humanely. Their globes were enucleated and bisected coronally just anterior to the equator for gross examination from the Miyake-Apple view to assess capsular bag opacification. After IOL explantation for power measurements, the globes were sectioned and processed for standard histopathology.

Results: Slitlamp examinations performed after the laser treatments showed the formation of small gas bubbles behind the lenses that disappeared within a few hours. No postoperative inflammation or toxicity was observed in the treated eyes, and postoperative outcomes and histopathological examination results were similar to those in untreated eyes. The power measurements showed that the change in power obtained was consistent and within ±0.1 diopter of the target.

Conclusions: Consistent and precise power changes can be induced in the optic of commercially available IOLs in vivo by using a femtosecond laser to create a refractive-index shaping lens. The laser treatment of the IOLs was biocompatible.

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LABORATORY SCIENCE

IOL power adjustment by a femtosecond laser: *In vitro* evaluation of power change, MTF, light transmission, and light scattering in a blue-light filtering lens

Jason Nguyen, MD, Liliana Werner, MD, PhD, Jason Ludlow, MD, Joah Aliancy, MD, Larry Ha, BS, Bryan Masino, BS, Sean Enright, BS, Ray K. Alley, BS, Ruth Sahler, MSc.

Purpose: To evaluate intraocular lens (IOL) power, modulation transfer function (MTF), light transmission, and light scattering of a blue-light filtering IOL before and after power adjustment by femtosecond laser, obtained through increased hydrophilicity of targeted areas within the optic, creating the ability to build a refractive index shaping lens within an existing IOL.

Setting: John A. Moran Eye Center, University of Utah.

Study Design: Experimental study.

Methods: Ten CT LUCIA 601PY (commercially available single-piece, hydrophobic acrylic yellow lenses; Zeiss) IOLs were used in this study. IOL power and MTF were measured with a Lambda-X PMTF device. Light transmission was measured using a PerkinElmer Lambda 35 UV/Vis spectrophotometer. Back light scattering was assessed with a Scheimpflug camera within the IOL substance. All measurements were done in the hydrated state. The lenses were also evaluated under light microscopy before and after laser adjustment.

Results: After laser adjustment, a mean power change of -2.037 D was associated with a MTF change of -0.064, and a light transmittance change of -1.4%. Back light scattering increased within the lens optic in the zone corresponding to the laser treatment, at levels that are not expected to be clinically significant. Treated areas within the optic could be well appreciated under light microscopy, without any damage to the IOLs.

Conclusion: Power adjustment of a commercially available hydrophobic acrylic, blue-light filtering lens by femtosecond laser produced an accurate change in dioptric power while not significantly affecting the quality of the IOL.

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The Future of Cataract

- Collaboration is key
- Bond between optometry and ophthalmology will continue to evolve
- No more unhappy patients ;)