



IOL options for addressing presbyopia



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Financial disclosure:
Alcon: C
Carl Zeiss Meditec: C
Ivantis: C
J & J Vision: C
PerfectLens: C
PowerVision: C, S
Revision Optics: C





Many options

- ◆ Monovision
- ◆ Multifocal IOLs
 - Standard
 - Low add
- ◆ Extended depth of focus
- ◆ Trifocal IOLs



Monovision: Indications

- Previous success with CLs
- Desire greater spectacle freedom and:
 - Have mild sight-threatening pathology or
 - Fully functional distance vision in first eye:
 - ◆ Likely will tolerate near in second eye



Monovision strategy: Distance vision is key

- If a "typical" eye for IOL calcs:
 - Do distance eye first
 - Decide on near eye depending on outcome
- If an "atypical" eye, eg, small eye:
 - Do the near eye first
 - "Go to school" on outcome of first eye

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Monovision: Advantages

- Preserves quality of vision
- Can be fully corrected with glasses
- Can be reversed with corneal laser surgery

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Monovision: Disadvantages

- Unlike refractive surgery:
 - ⇓
 - Often cannot test with contact lenses
 - Due to decreased vision in one or both eyes

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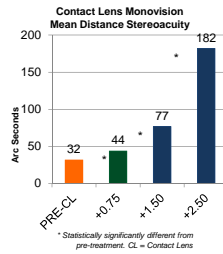
Monovision: Disadvantages

- May need 2 pairs of spectacles
 - Driving at night for near eye
 - Prolonged reading for distance eye
- Not always tolerated
- "Out-of-focus" eye can create haloes or glare



Stereopsis and monovision

- Even +0.75 D of monovision reduces stereopsis



Durrie D., The Effect Of Different Monovision Contact Lens Powers On The Visual Function Of Emmetropic Presbyopic Patients. Trans Am Ophthalmol Soc. 2006;104:366-371



Multifocal IOLs

- Good near vision
- Halos
- Finicky re
 - Spherical equivalent
 - Astigmatism
 - Any ocular pathology



Tecnis ZKBoo, ZLBoo, and ZMBoo

• Better reading in low light
• More halos at night

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Multifocal IOLs

- Largely abandoned in Europe in favor of:
 - EDOF IOLs
 - Trifocal IOLs


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Is there an IOL that finally meets patient and physician expectations?

- ◆ Clear, high-quality vision
- ◆ Increased depth of focus


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The short answer is no, but...





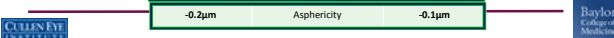
New IOLs: Low add and EDOF

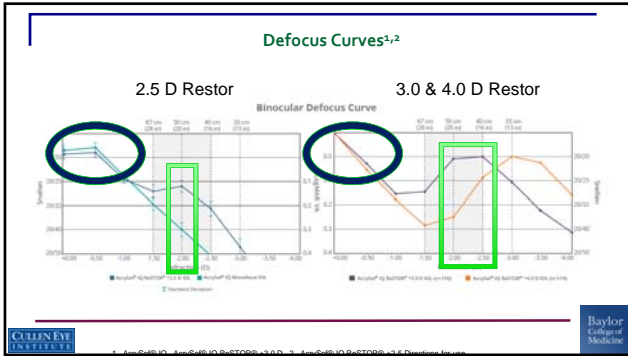
- Less glare
- Better intermediate vision
- Better quality of vision



AcrySof® IQ ReSTOR® IOL

+2.5 D	+2.5 D ¹	Parameter	+3.0 D ¹	+3.0 D
	SV25T0	Model number	SN6AD1	
	+2.5 D	ADD power @ IOL plane	+3.0 D	
	+2.0 D	ADD power @ Spectacle Plane	+2.5 D	
	0.94 mm	Central ring diameter	0.86 mm	
	7	# rings	9	
	8.4 mm ²	Apodized Diffractive Area	10.2 mm ²	
	Dist: 69% Near: 18.0%	Energy distribution (3 mm IOL plane)	Dist: 59% Near: 25.5%	
	-0.2µm	Asphericity	-0.1µm	





Restor 2.5 D

- Great distance
- Usually good intermediate
- Rarely also get near
- Pupil dependent
- Halos minimal: the sweet spot for this IOL

74 yo orthopedic surgeon: OS dominant

- Bilateral Restor 2.5 D IOLs
- OS: 20/20, J3-4
 - Plano
- OD: 20/30, J1
 - -0.75
- Very happy—often needs +1.00 readers

EDOF: Achromatic diffractive technology

Cornea
All corneas have a similar amount of chromatic aberration

Lens with Achromatic Technology
Use diffractive optics to reduce corneal CA

Cornea+ Lens with Achromatic Technology
The net result is reduced chromatic aberration

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Another approach: extended depth of focus (EDOF)

Hybrid diffractive-refractive achromatic camera Lens

Photographic Lens
Telefoto lens
(Canon EF400mm f/4 DO IS USM)

Multilayer Diffractive Optical Element

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Diffractive features in TECNIS Symphony® IOL's Design

Multifocal

Monofocal (Achromat)

Symphony

"Echelletes" add multifocality & reduce chromatic aberration: **EDOF**

Less chromatic aberration than a phakic eye

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Diffraction optics also elongate the focus

Monofocal IOL

Multifocal IOL

Symfony

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Tolerance to astigmatism

- This tubular zone of good focus creates both:
 - Depth of focus
 - Tolerance to astigmatism

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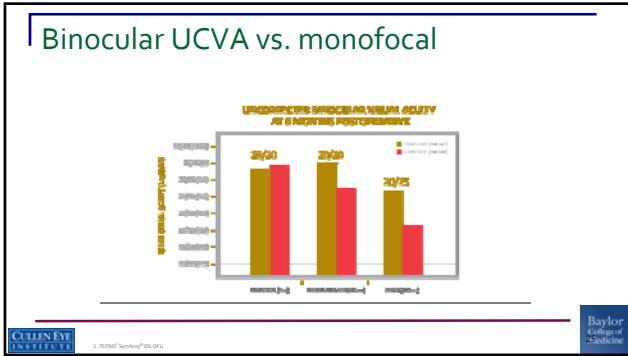
Continuous +1D increased range of focus

BINOcular DEFOCUS CURVE AT 6 MONTHS

Defocus (D)	Symfony (logMAR)	Monofocal (logMAR)
-2.0	0.2	0.2
-1.5	0.1	0.1
-1.0	0.0	0.0
-0.5	0.1	0.1
0.0	0.2	0.2
0.5	0.3	0.3
1.0	0.4	0.4
1.5	0.5	0.5
2.0	0.6	0.6
2.5	0.7	0.7
3.0	0.8	0.8
3.5	0.9	0.9
4.0	1.0	1.0

- Sustained mean visual acuity of 20/25 or better through 1.5 D of defocus
- Increase of 1.0 D range of vision throughout the defocus curve compared to a monofocal

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- ### How to get better near vision?
- ◆ Mix and match
 - Restor 2.5 and 3.0
 - Tecnis Symfony and ZLBoo
 - ◆ Micromonovision: what I have been doing
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Case #1

- 58 year old female attorney/CEO
- Pre-op:
 - MR:
 - ◆ OD: $-6.50 + 1.00 \times 60 = 20/30$
 - ◆ OS: $-6.25 + 0.75 \times 95 = 20/30+1$

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OS surgery

- 13.5 D ZXRoos with femto IS CRIs: 2x35 @ 110
 - Target of -0.50
- POM #1
 - UDVA = 20/30, near = J1+
 - MR: -0.50 sph = 20/20

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OD surgery

- 13.5 D ZXRoos with femto IS CRIs: 2x45 @ 60
 - Target plano
- POM #1
 - UDVA = 20/20, near = J1
 - MR: -0.25 sph = 20/20

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What you don't want to see...but must discuss

Oncoming car on street at night. The circle of light is on the center, with most of the light, then the headlights. (circle of light is on the center, with most of the light, then the headlights.)

Head light

Left eye

Right eye

Original line 319

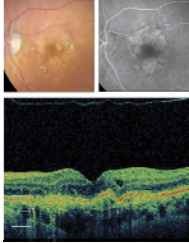
Original line 1497

Handwritten notes and diagrams illustrating surgical considerations for an oncoming car on a street at night. The diagrams show the layout of headlights and the resulting light patterns on the eye, with labels for 'Left eye' and 'Right eye' and 'Original line' numbers.

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Expand range of potential patients?

- ◆ Post-LASIK
- ◆ AMD
- ◆ Glaucoma with NFL loss
- ◆ Makes me less worried if patients later develop these

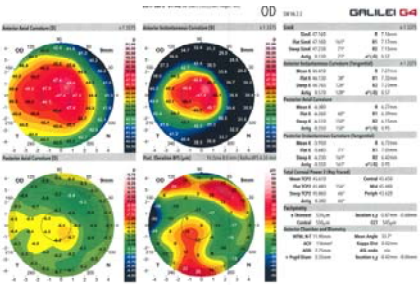


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Case #2

- 70 year old male
- Prior hyperopic LASIK OU
- Pre-op:
 - MR:
 - ◆ OD: +1.50 + 0.75 x 135
 - ◆ OS: +1.50 + 0.25 x 65

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Visual Field	Mean	SD	Upper	Lower	Upper	Lower
OD	13.1	1.2	15.5	10.7	16.5	9.7
OS	13.1	1.2	15.5	10.7	16.5	9.7

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ZXRoo IOLs implanted for distance

- Both eyes have:
 - UDVA = 20/20, near = J1+
 - Minimal starburst at night

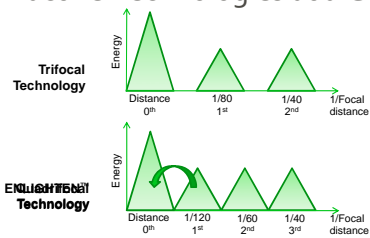


Stay tuned

- New EDOFs
 - Alcon
 - Carl Zeiss
- Trifocal IOLs
 - Panoptix



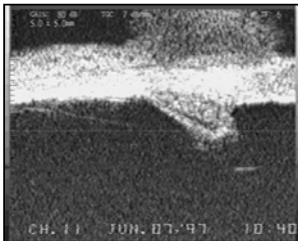
Diffractive Technologies at a Glance



UBM image of unaccommodated eye



UBM image of accommodated eye



How do we harness this movement in the pseudophakic eye?

- Change in optic:
 - Position
 - Curvature
 - Power
- Or combinations of these

Where do we harness this movement?

- Capsular bag
- Ciliary sulcus

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Do we even try to harness this movement?

- Use other accommodative changes:
 - Pupillary constriction
 - Convergence


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What biomaterials do we use?

- Silicone
- Acrylic
 - Hydrophilic
 - Hydrophobic
- Other

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What's available now?





Single-optic: Crystalens

- Does it move?
 - < 1 mm if at all in most eyes
- Other proposed mechanism:
 - IOL flexure with accommodation

↓



“Accommodative arching”



Single-optic: Crystalens → capsule

◆ Mechanism:

- ✓ Optic moves?
- ✓ Optic changes shape?



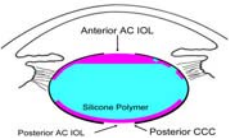
Crystalens HD vs. SN60WF: 1 m postop (Yeu et al)

Criteria	Crystalens HD (n=19)	SN60WF (n=29)
BCDVA	-20/20 LogMAR 0.01 ± 0.07 (-0.12 to 0.10)	20/20 LogMAR 0.00 ± 0.06 (-0.12 to 0.10)
DCNVA (840nm)	J5 - J6 LogMAR 0.34 ± 0.24 (0.1 to 0.5)	J7 LogMAR 0.47 ± 0.26 (0.10 to 0.90)
AA (in D)	*1.99 ± 0.61 (1.05 to 3.02 D)	*1.14 ± 0.59 (0.46 to 3.20 D)
Pupil (mm)	**2.75 ± 0.31 (2.10 to 3.2)	**3.16 ± 0.60 (1.90 to 4.50 mm)


*Significantly different in AA and ** pupil size between groups (p<0.05); other comparisons p>0.05
 • No significant correlations seen between AA and pupil size

True restoration of accommodation

- PowerVision: FluidVision IOL
 - Other options in earlier stages
- Injectable, flexible IOL.... still a long way off



Thank you for your attention!



Chromatic aberration less than phakic eye

