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Hitting Refractive Targets – The Lens Approach

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Financial Disclosure

Abbott Medical Optics, Inc.
Advanced Vision Science, Inc.
Bausch & Lomb Surgical, Inc.
Carl Zeiss Surgical, Inc.
Celgene, Inc.
GE Healthcare
Haag-Streit USA
Ista Pharmaceuticals
Rayner Intraocular Lenses, Ltd.
Surgiview LLC
Transcend Medical, Inc.
TrueVision Systems, Inc.
WaveTec Vision Systems

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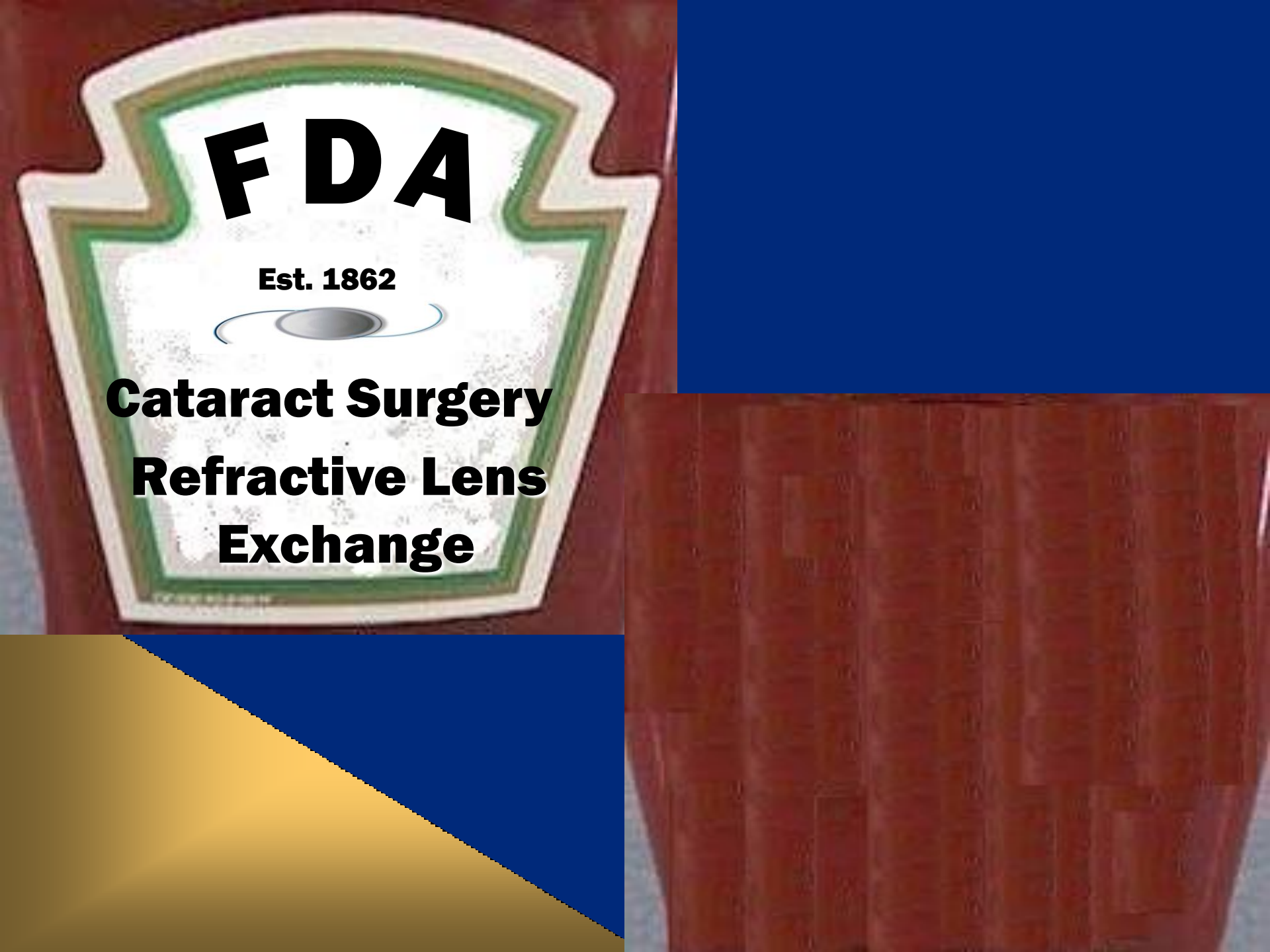
FDA
Est. 1862
Cataract Surgery
Refractive Lens
Exchange

OVER HALF A MILLION COPIES SOLD!

SIGHT WITHOUT GLASSES

DR. HAROLD M. PEPPARD

Drivers of Satisfaction

- Knowledge of available IOLs
- Understanding of patient goals
- Communication of expectations
- Accurate preoperative measurements
- Meticulous surgical technique

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Drivers of Satisfaction

- Knowledge of available IOLs

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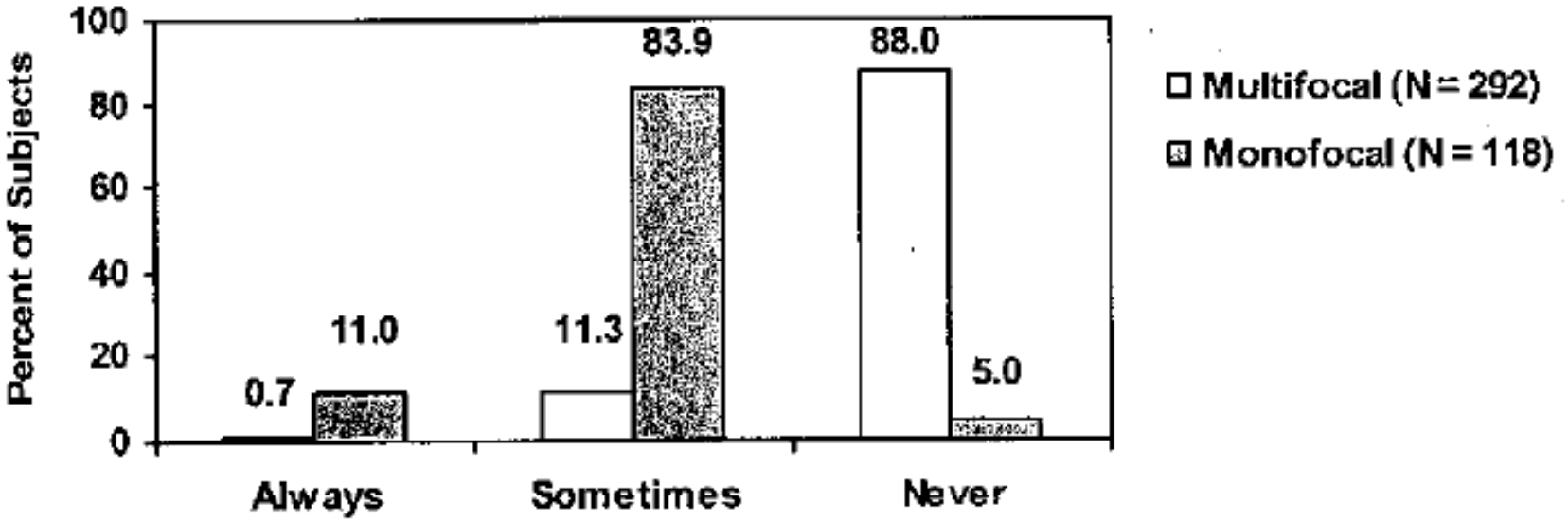
Summary of Safety and Effectiveness Data (SSED)
Tecnis® Multifocal Intraocular Lens, Models ZM900 and ZMA00

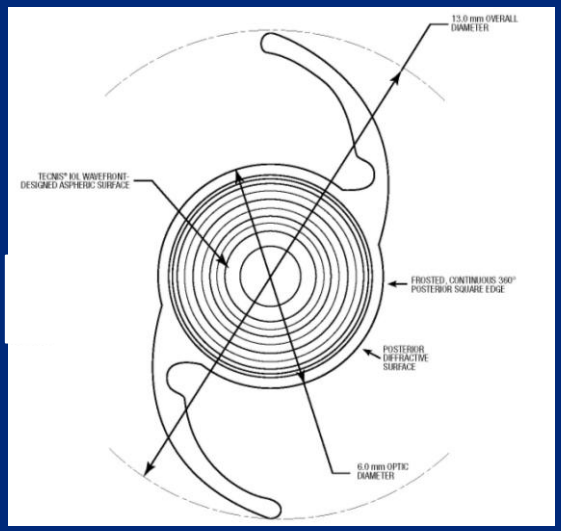
Figure 3
Overall Frequency of Spectacle Wear for Bilateral Subjects at 4-6 Months



http://www.fda.gov/cdrh/pdf8/P080010b.pdf

Lens Factors Affecting Spectacle Independence

- Pupil-independence:
  - Full diffractive surface
- Crisp vision:
  - Zero spherical aberration
  - Lower chromatic aberration
  - Full blue light transmission
- Range of vision:
  - High-quality intermediate without sacrificing near vision



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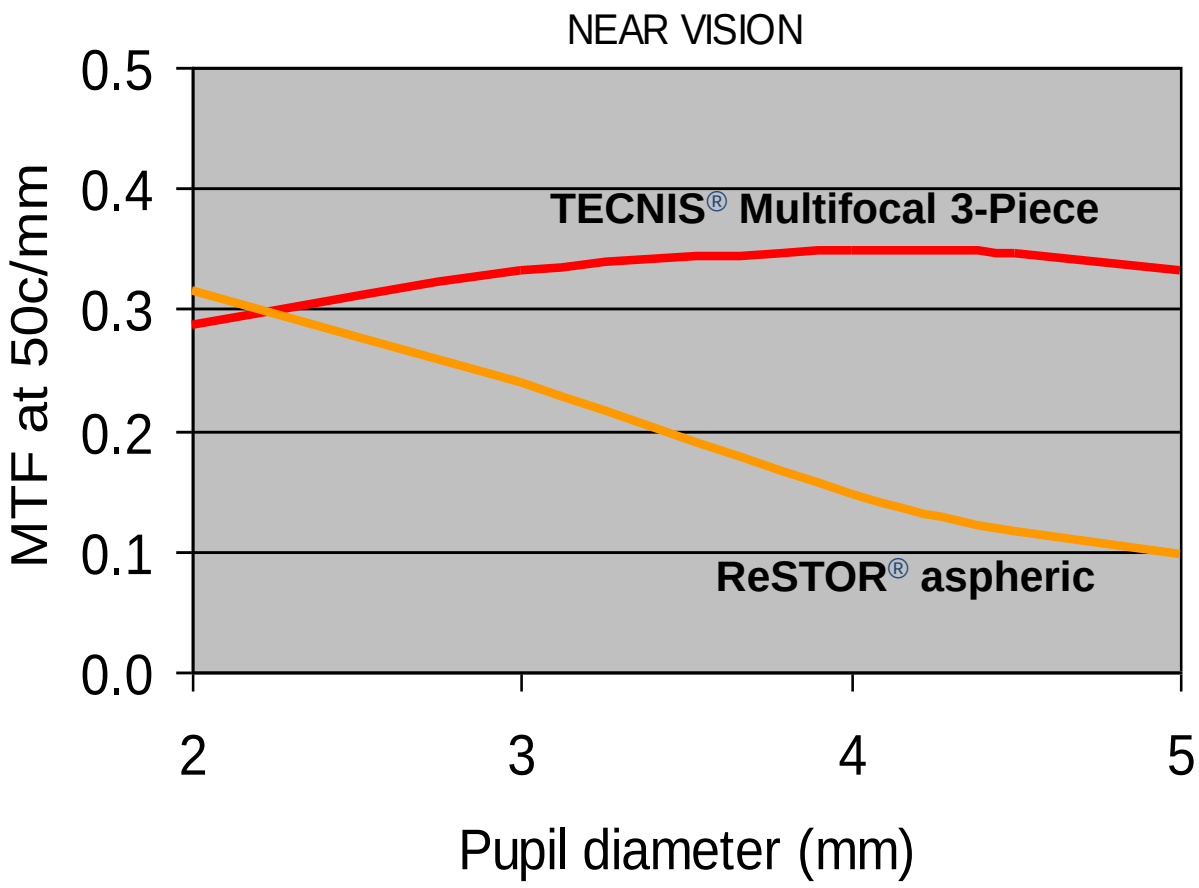
Full Diffractive Surface = Pupil Independence

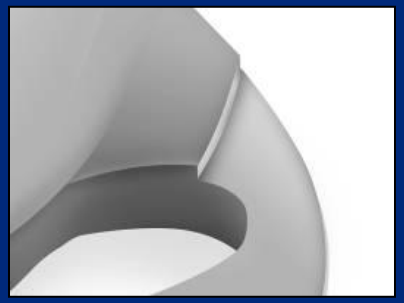


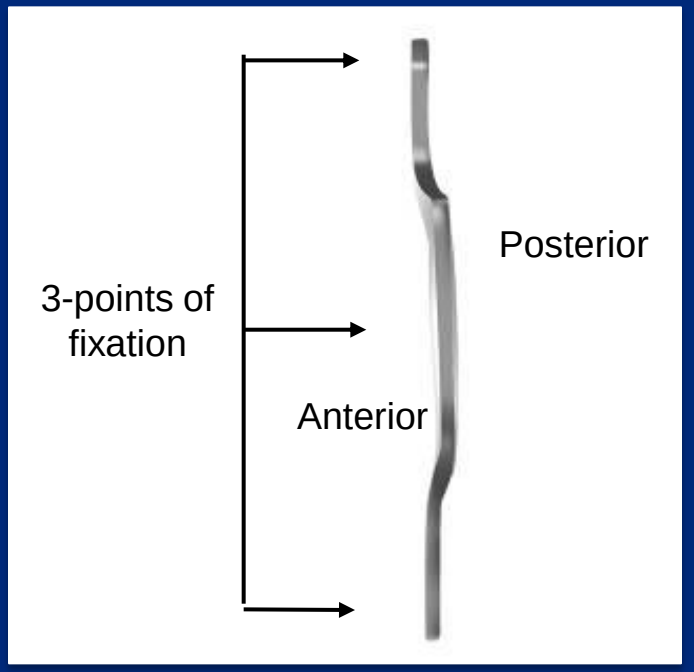
TECNIS Multifocal: Light remains equally distributed between near and distance as the pupil size increases.

ReSTOR: The apodized diffractive design becomes more distance-dominant as the pupil widens, reducing visual quality for near.

Updated Single Piece Design

- The 360˚ square edge limits LEC migration at the haptic-optic junction
- Offset haptic design provides 3 points of fixation:
  - Refractive predictability
  - Long-term stability
  - Centration





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Lens Glistenings

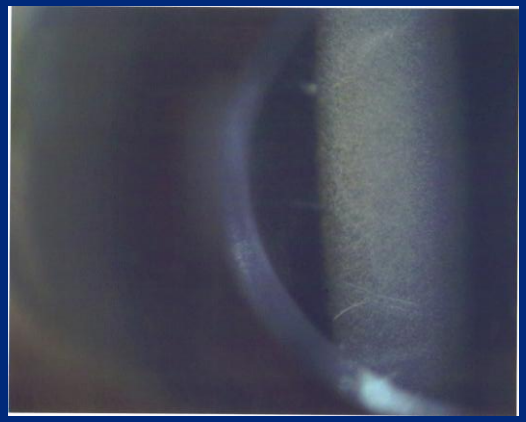
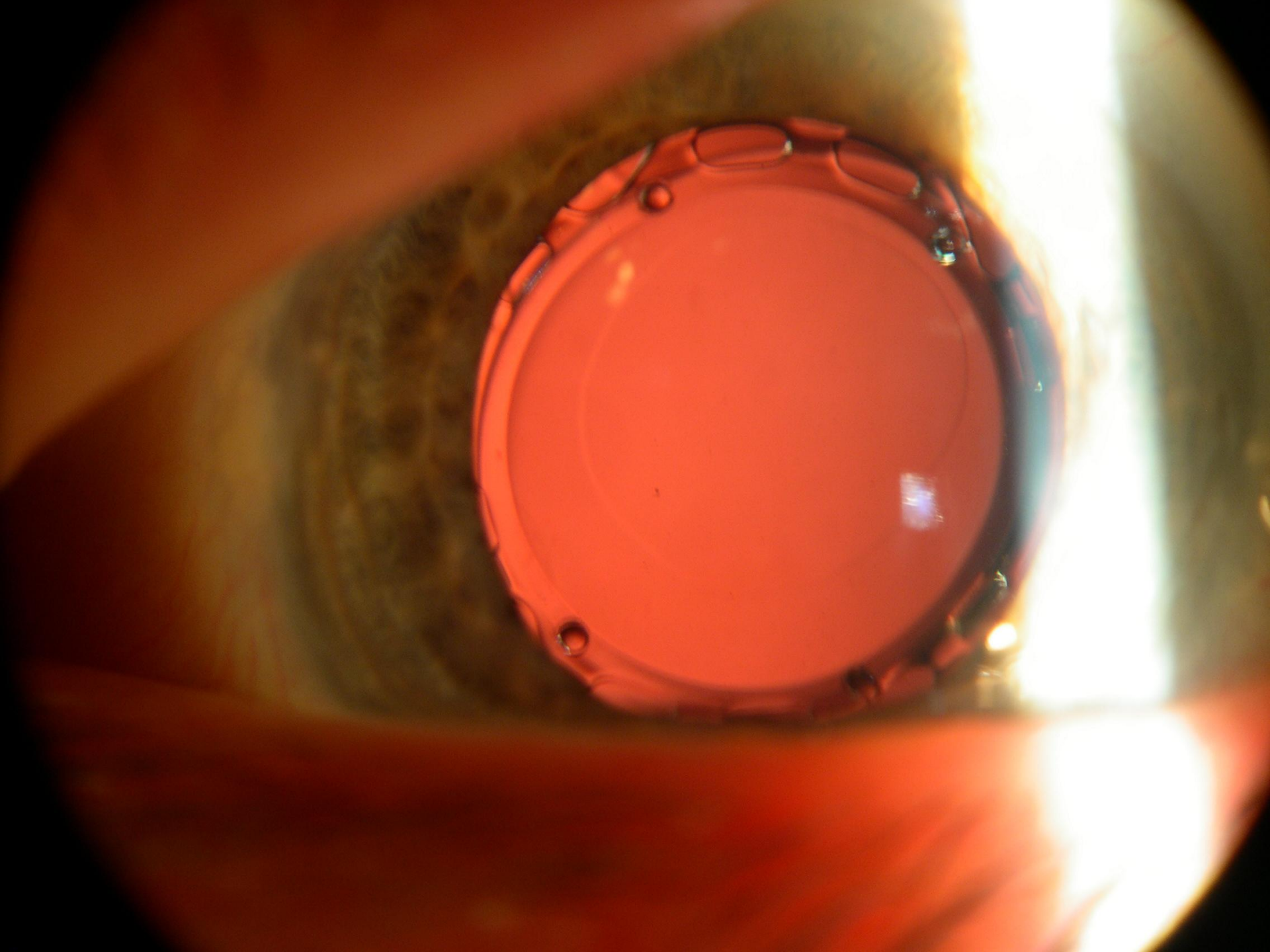


Image courtesy of Dr. Wittpenn

- Small lens vacuoles
  - Temperature changes allow water to collect in gaps
  - Injection molded vs. lathe-cut material
  - Visible due to differences in refractive index
- Incidence of vacuoles range from 30% to 100%[1-3]
- Up to 25% show visual acuity detriment[3]

1-Gunenc U, Oner FH, Tongal S, Ferliel M. Effects on visual function of glistening and folding marks in AcrySof intraocular lenses. J Cataract Refract Surg 2001;27(10):1611-4.
2 -Moreno-Montañés J, Alvarez A, Rodríguez-Conde R, Fernández-Hortelano A. Clinical factors related to the frequency and intensity of glistening in AcrySof intraocular lenses. J Cataract Refract Surg 2003;29(10):1980-4.
3-Christiansen G, Durcan FJ, Olson RJ, Christiansen K. glistening in the AcrySof intraocular lens: Pilot study. J Cataract Refract Surg 2001;27(5):728-33.



Drivers of Satisfaction

- Understanding of patient goals
- Communication of expectations

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Physician Time with Patients

- 56 bilateral cataract patients
  - Monofocal (32)
  - Multifocal (13)
  - Accommodative (11)

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Packer M. Physician Chair Time and Premium IOLs. ASCRS Paper Session 2-B: Intraocular Surgery, Accommodating IOLs. American Society of Cataract and Refractive Surgery Symposium on Cataract, IOL and Refractive Surgery. 3 – 8 April 2009, San Francisco, CA.

Mean Pre Op Physician Time

- Monofocal (32): 14.4 min
- Multifocal (13): 11.8 min
- Accommodative (11): 16.4 min

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Mean Post Op Visits (90 days)

- Monofocal (32): 5.2
- Multifocal (13): 4.3
- Accommodative (11): 4.4

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Mean Post Op Time per Visit

- Monofocal (32): 5.0 min
- Multifocal (13): 5.5 min
- Accommodative (11): 7.7 min

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Total Post Op Time (90 days)

- Monofocal (32): 26.7 min
- Multifocal (13): 25.5 min
- Accommodative (11): 34.8 min

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Drivers of Satisfaction

- Accurate preoperative measurements

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Table 26
Desire to Elect IOL Again for Bilateral Subjects
Directed Response to a Prompted Choice Questionnaire

	Tecnis ZM900				CeeOn 911A			
	4-6 Months N = 292		One Year N = 112		4-6 Months N = 118		One Year N = 115	
Elect IOL Again?	n	%	n	%	n	%	n	%
Yes	255	87.3	106	94.6	100	84.7	103	89.6
No	30	10.3	5	4.5	15	12.7	12	10.4
Undecided	7	2.4	1	0.9	3	2.5	0	0.0

For A-scan I use … most often

Applanation (contact)	55	9.4%
Immersion (noncontact)	100	17.1%
Partial Coherence Interferometry (IOL Master)	431	73.5%

Leaming D. 2008
Survey of ASCRS Members.
http://www.analeyz.com/

Preferred method of Keratometry for IOL calc?	Manual	149	24.9%
	Auto K	64	14.3%
	IOL Master	354	63.6%
	Topography/ corneal analyzer	31	13.0%
Preferred method of keratometry for Toric IOL calc?	Manual	172	33.3%
	Auto K	36	7.0%
	IOL Master	148	28.7%
	Topography/corneal analyzer	160	31.0%
What IOL power formula do you primarily use?	SRK	4	0.7%
	SRK II	65	11.5%
	SRK/T	194	34.2%
	Holladay 1	119	21.0%
	Holladay 2	156	27.5%
	Haigis	18	3.2%

Immersion A-scan compared with partial coherence interferometry

Outcomes analysis

Mark Packer, MD, I. Howard Fine, MD, Richard S. Hoffman, MD, Peggy G. Coffman, COT, Laurie K. Brown, COMT, COE

ABSTRACT

Purpose: To compare 2 methods of axial length measurement, immersion ultrasonography and partial coherence interferometry, and to elucidate surgical outcomes based on immersion measurements.

Setting: Oregon Eye Institute, Eugene, Oregon, USA.

Methods: Axial length measurements in 50 cataractous eyes were obtained by optical biometry (IOLMaster®, Zeiss Humphrey Systems) and immersion ultrasound (Axis II, Quantel Medical), and the results were compared. Intraocular lens (IOL) power calculations in the same eyes after cataract extraction and posterior chamber IOL implantation were evaluated retrospectively based on the postoperative spherical equivalent prediction error.

Results: Immersion ultrasonography and partial coherence interferometry measurements correlated in a highly positive manner (correlation coefficient = 0.996). Outcomes analysis demonstrated 92.0% of eyes were within ±0.5 diopter of emmetropia based on immersion axial length measurements.

Conclusion: Immersion ultrasonography provided highly accurate axial length measurements and permitted highly accurate IOL power calculations. *J Cataract Refract Surg 2002; 28:239–242 © 2002 ASCRS and ESCRS*

Axial length measurement remains an indispensable technique for intraocular lens (IOL) power calculation. Recently, partial coherence interferometry has emerged as a new modality for biometry.[1] Postoperative results achieved with this modality have been considered "analogous" to those achieved with the ultrasound immersion technique.[2] Reportedly "user-friendly" and less dependent on technician expertise than ultrasound methods, noncontact optical biometry is, however, limited by dense media, eg, posterior subcapsular cataract. A second limitation of the optical method is the lack of a lens thickness measurement, a required variable in the Holladay 2 IOL power calculation software, version 2.30.9705. However, according to Holladay, the lens thickness can be estimated by the formula 4.0 + (age/100). Also, optical biometry can provide keratometry measurements, obviating the need for a second instrument.

Immersion ultrasound is an accurate method of axial length measurement, generally considered superior to

Accepted for publication October 10, 2001.

From Oregon Eye Institute, Eugene, Oregon, USA.

None of the authors has a proprietary or financial interest in any product mentioned.

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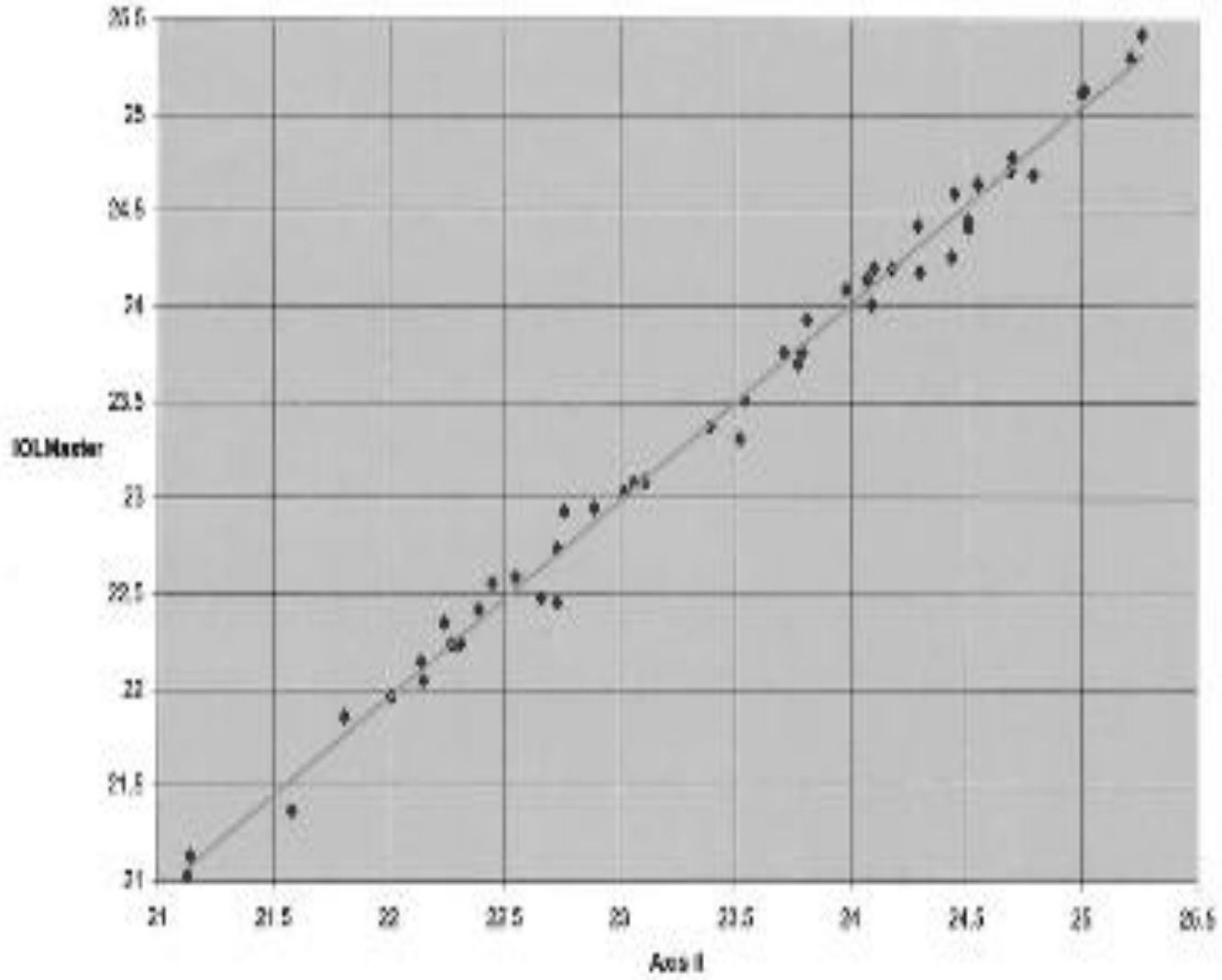

Figure 1. (Packer) Comparison of axial length measurements by immersion ultrasound (abscissa) and optical coherence interferometry (ordinate). The linear regression trend line reflects the high correlation between the 2 sets of values (correlation coefficient = 0.996).

Preoperative Measurements

- Immersion Ultrasound
- IOL Master
  - Partial coherence interferometry measures axial length
  - Keratometry, anterior chamber depth and corneal white-to-white measurements

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Optical Low Coherence Reflectometry (OLCR)

- SLD 820 nm interferometry
- Simultaneous measurements
- Alignment on visual axis

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The Lenstar is based on OLCR. An SLD at 820 nm coupled to the reflectometer is used as a measurement and fixation beam for the patient. The reflections of the different structures within the human eye such as the cornea, lens, and retina are interferometrically superimposed on the reflections of the reference arms. An interference signal from a reflective interface is generated when the measurement beam is fixated by the patient and when it is perpendicular to the interface. Because of the temporal separation of the interferences, the corneal thickness, the ACD (with or without cornea thickness), the LT, and the axial eye length are measured simultaneously in a single positioning procedure. The device also acquires corneal radius measurements in the flat and steep meridian by analyzing a pattern of 32 light-emitting diodes (LEDs), which are arranged on 2 rings with 16 measuring points each. To assure comparable head position, great care was taken that the temporal lid canthus of the right and left eyes was adjusted exactly to the engraved lines on the holding bars of the chin rest (points of reference). The principles of the IOLMaster and Pachμmeter (Haag-Streit AG) have been described elsewhere before.[3,4,7] Calibration of the Lenstar is based on optical physics and against well-determined standard optical plates. Accurate details of the technology, refractive indices used, and software algorithms are Haag-Streit's proprietary information.

Lenstar --- One Touch

Keratometry: 32 markers

White to White Distance

Pachymetry: ± 2 μ

Anterior Chamber Depth

Lens Thickness

Pupillometry

Axial Length

Eccentricity of Visual Axis

Retinal Thickness

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IOL Calculations

Holladay 2 formula

- Takes into account disparities in anterior and posterior segment sizes
- IOL Consultant provides regression analysis and customization

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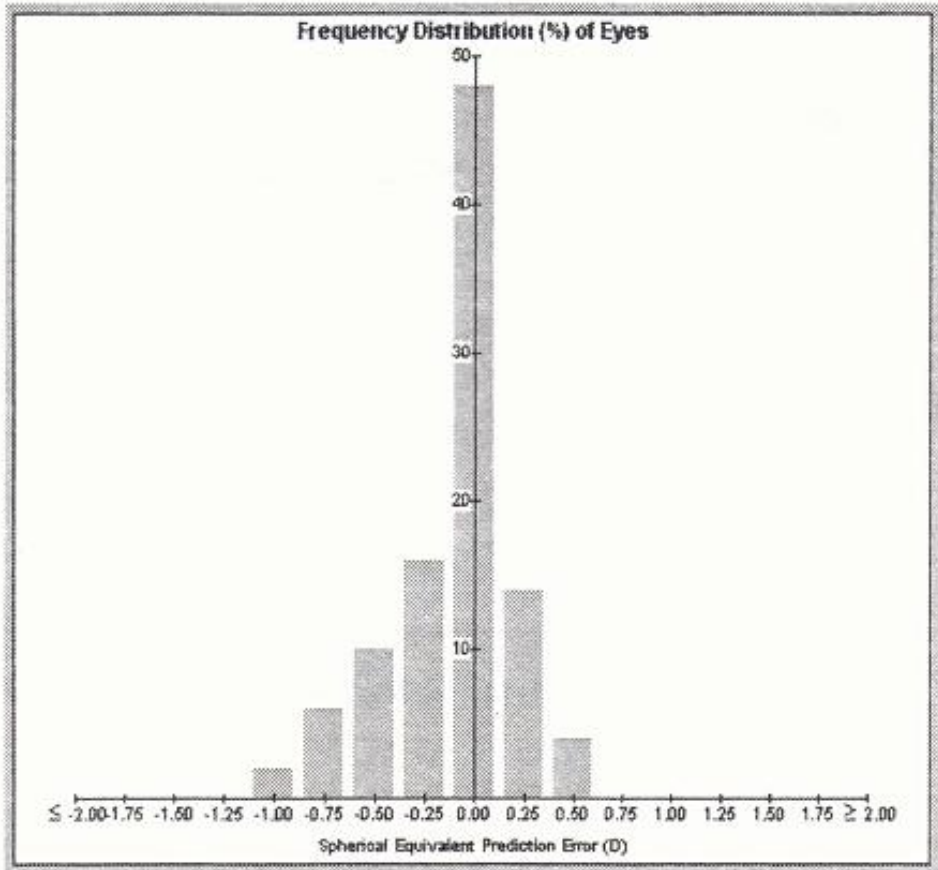

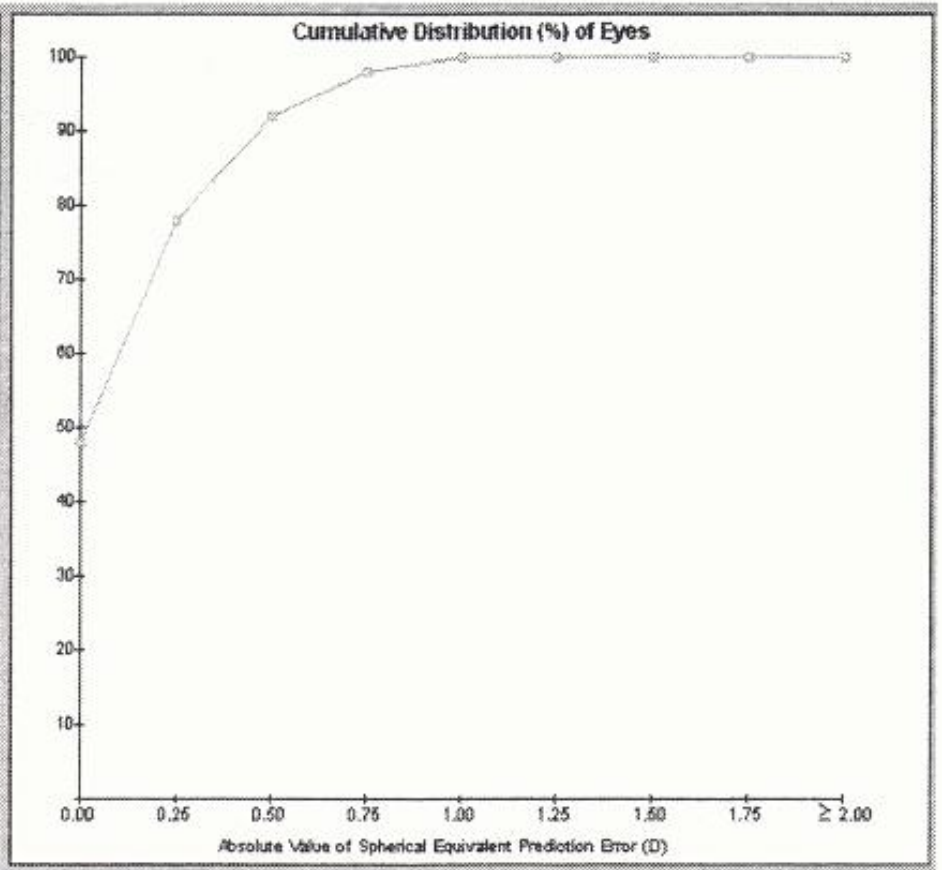

Formula	Number of Cases	Personalized ACD (mm)	Eqv. Form. Constant	Current Form. Constant	Mean Rx Err (D)	Mean Abs Rx Err (D)	Std Dev of Rx Err (D)	Max Rx Err (D)	% cases > +/- 2.0 D Rx
Holladay2	50	5.512 +/-0.040	ACD: 5.512	5.512	-0.105	0.215	0.305	-0.91	0.0%
Holladay1	50	5.765 +/-0.049	SF: 2.000	2.000	-0.118	0.222	0.336	-0.97	0.0%
HolferQ	50	5.763 +/-0.048	ACD: 5.763	5.763	-0.017	0.160	0.252	-0.86	0.0%
SRKT	50	5.817 +/-0.048	ACst 119.365	119.365	-0.091	0.260	0.341	-0.93	0.0%
HolladayR	50				0.000	0.000	0.000	0.00	0.0%

ORange Aberrometer

- Talbot moire interferometry
- Fourier transform
- Calculation of spectacle correction

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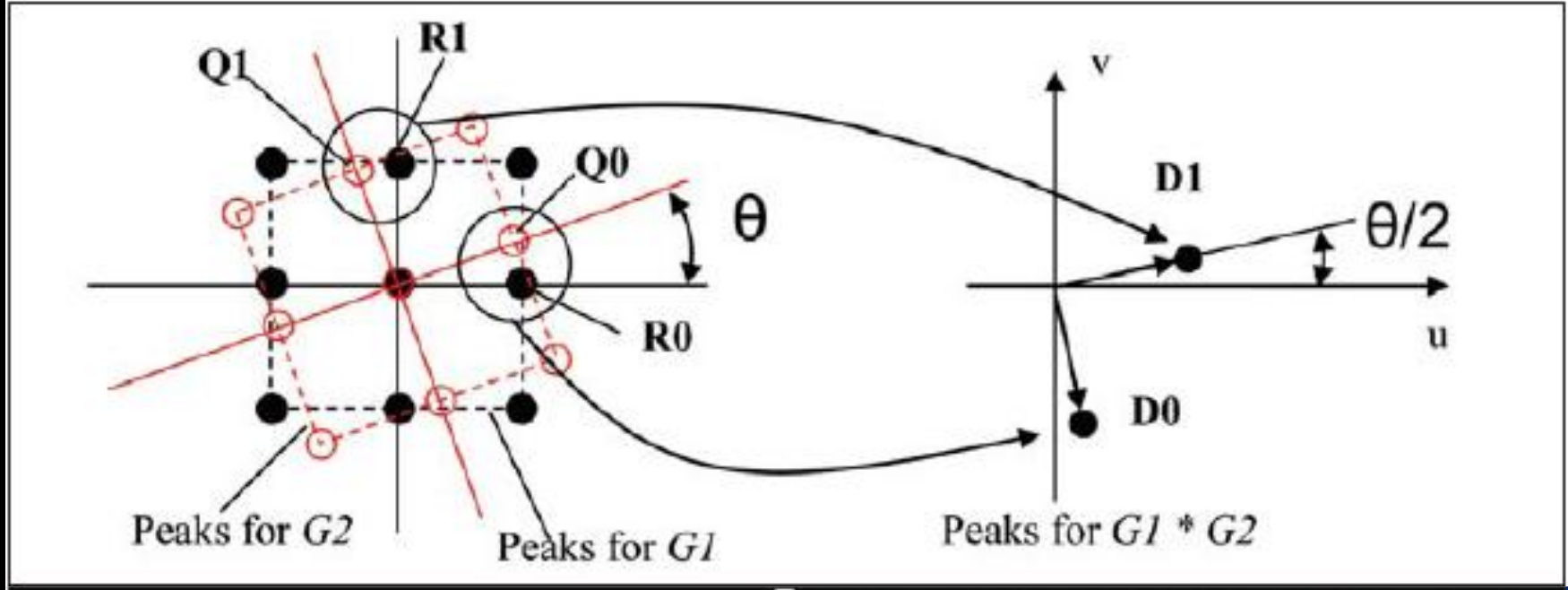

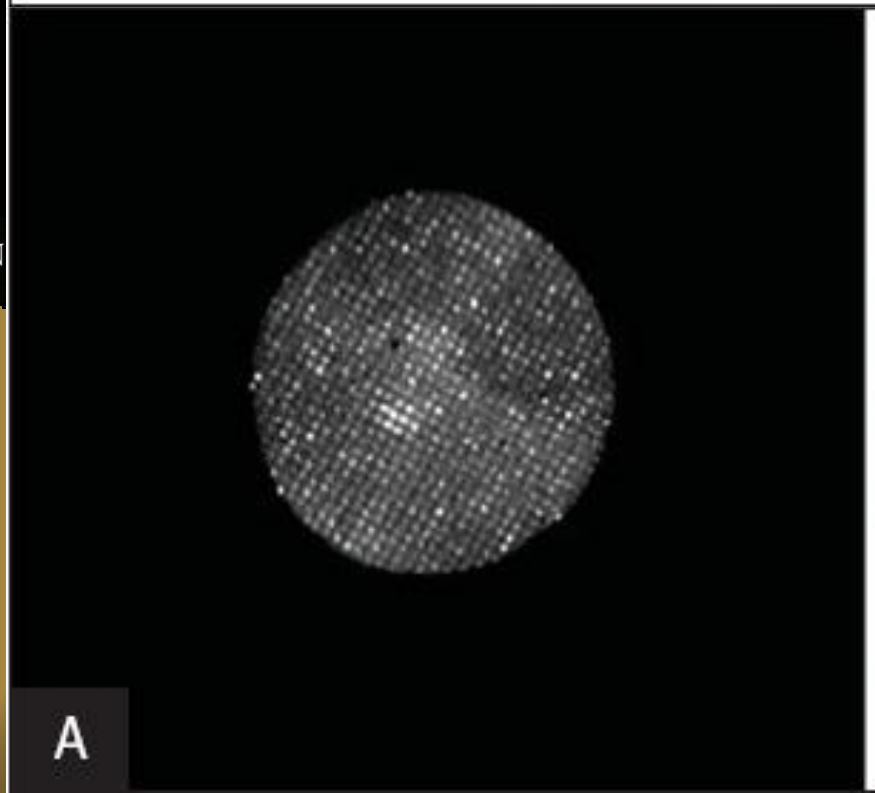

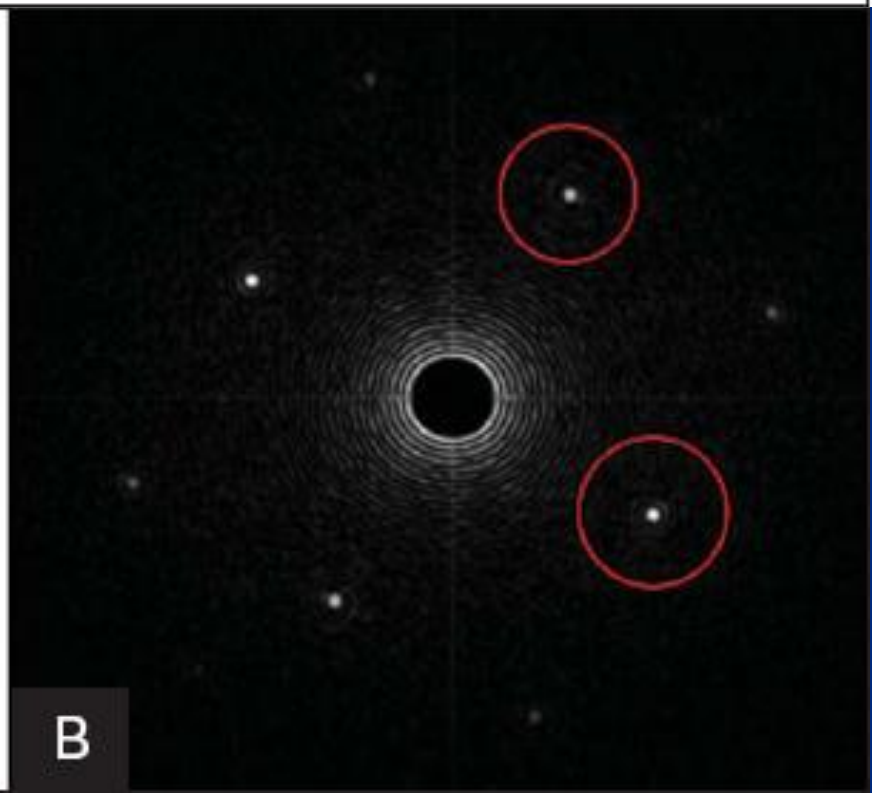

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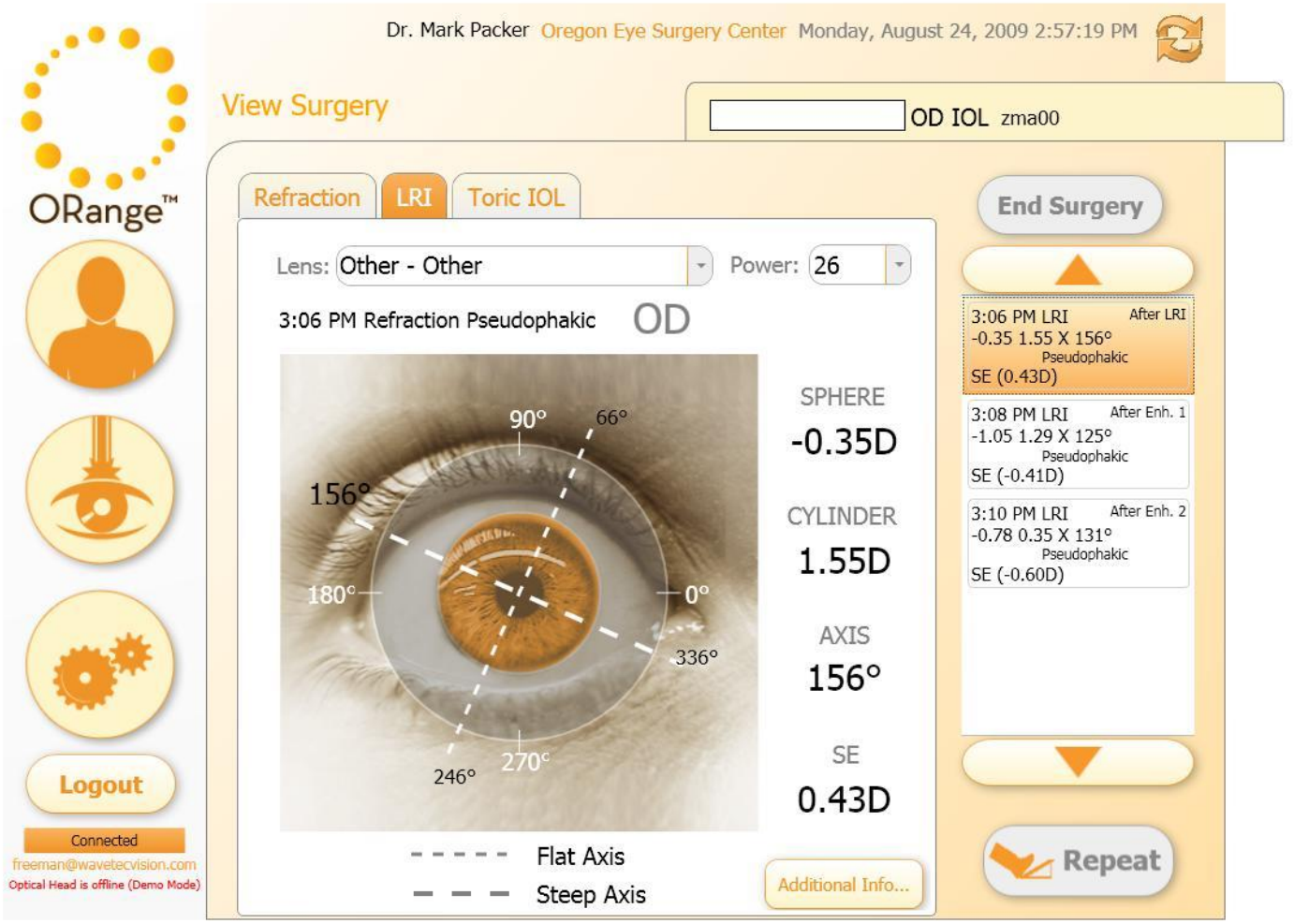
Carl Zeiss
OPMI Lumera T
Carl Zeiss



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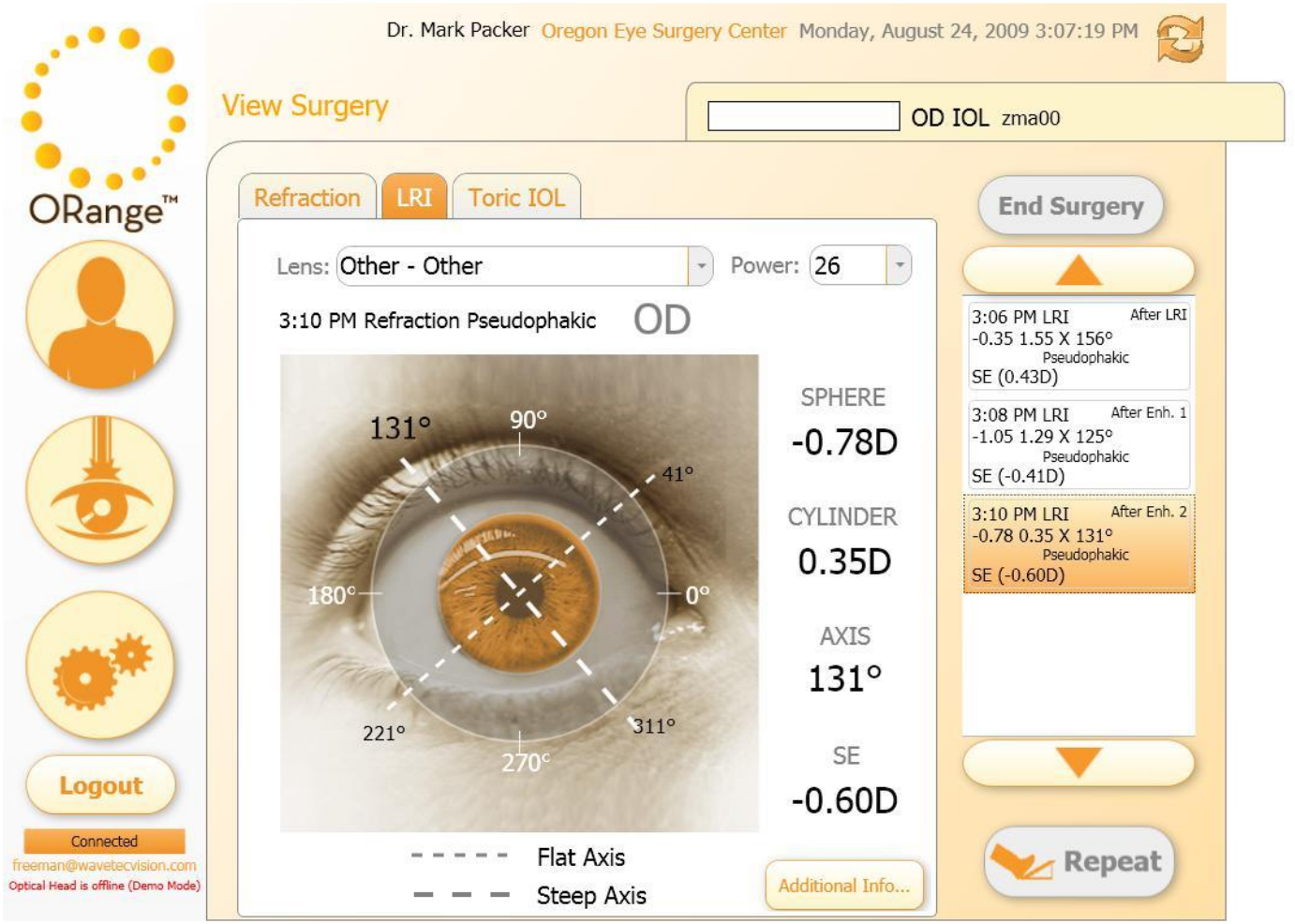

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Postoperative Characteristics

	Group 1	Group 2
Mean Sphere	-0.27	-0.33
Mean MRSE	+0.0	-0.15
Median UCVA	20/25	20/25
MR Cyl	0.48	0.37
≥ 0.75 D	10 (27%)	7 (23%)
≥ 1.00 D	9 (24%)	2 (6.6%)
≥ 1.25 D	4 (11%)	1 (3.3%)

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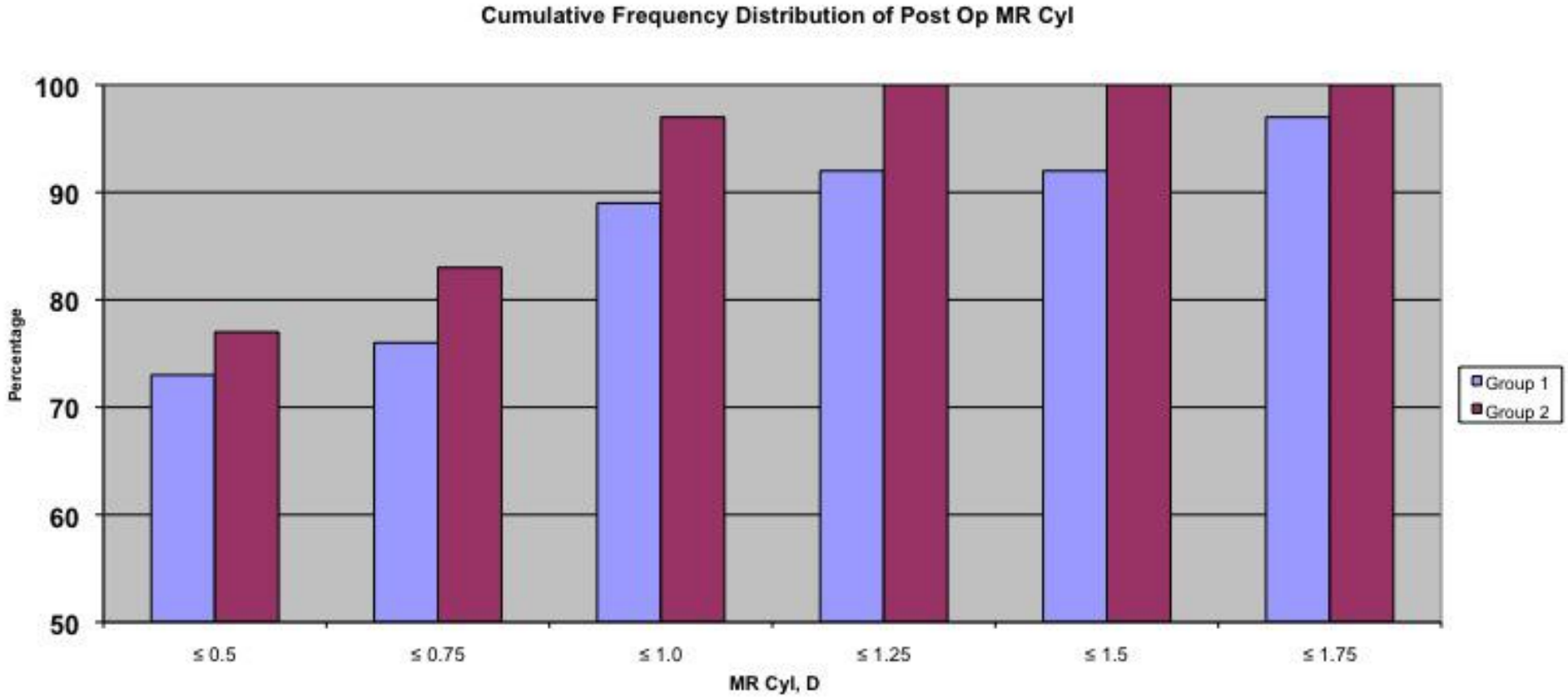
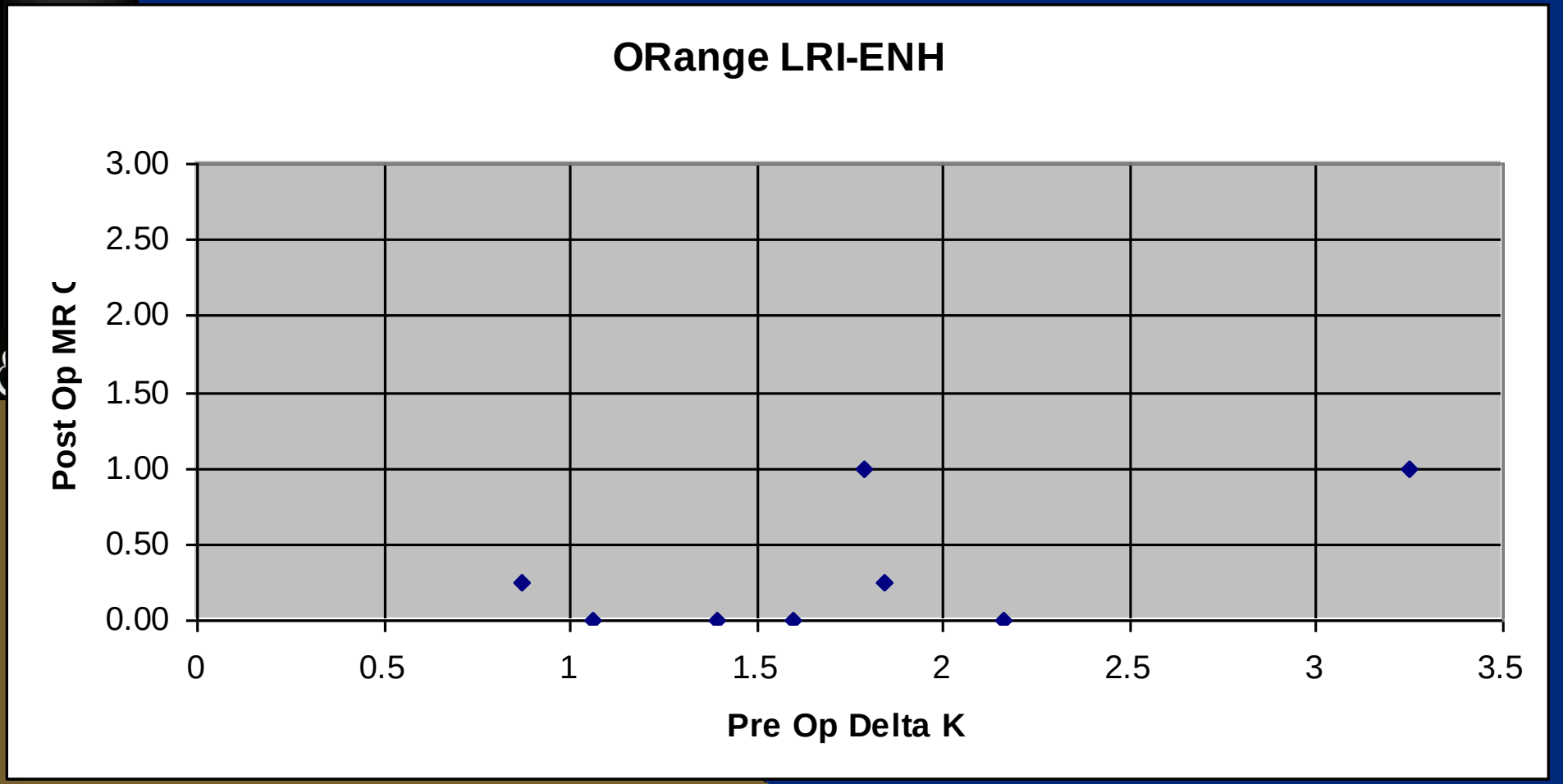

Cumulative Frequency Distribution of Post Op MR Cyl
100
90
80
70
60
50
Percentage
≤ 0.5
≤ 0.75
≤ 1.0
≤ 1.25
≤ 1.5
≤ 1.75
MR Cyl, D
Group 1
Group 2

Group 2 (LRI enhanced): ΔK v MR Cyl



Comparison of Enhanced Eyes

	Non-ORange w/LASIK enh n = 6/37 (16.2%)	**ORange w/LASIK enh** n = 1/30 (3.3%)	**ORange w/LRI enh** n = 8/30 (26.7%)
Age:Mean, SD	59.8 ± 3.7	58	62.2 ± 12.5
Pre-Op Delta K	1.70 D (0.76 - 2.32)	2.61 D	1.75 D (0.87 - 3.25)
Steep Axis	95º	78º	82º
Pre-op 10mm Pachymetry	664 microns	658 microns	655 microns
Post LRI	1.45 D (1.0 - 2.5) 1 month (n = 6)	1.00 D 1 month (n = 1)	0.31 D (0.00 – 1.00) 1 month (n = 8)
Post LASIK	0.95 ± 0.29D 7-16 months (n = 6)		0.42D 6 months (n = 3)

ORange Aberrometer

- Intraoperative wavefront guided enhancement of LRIs reduced the rate of postoperative excimer laser enhancement from 16.2% to 3.3%, an odds ratio of 5.71 (p=0.12).

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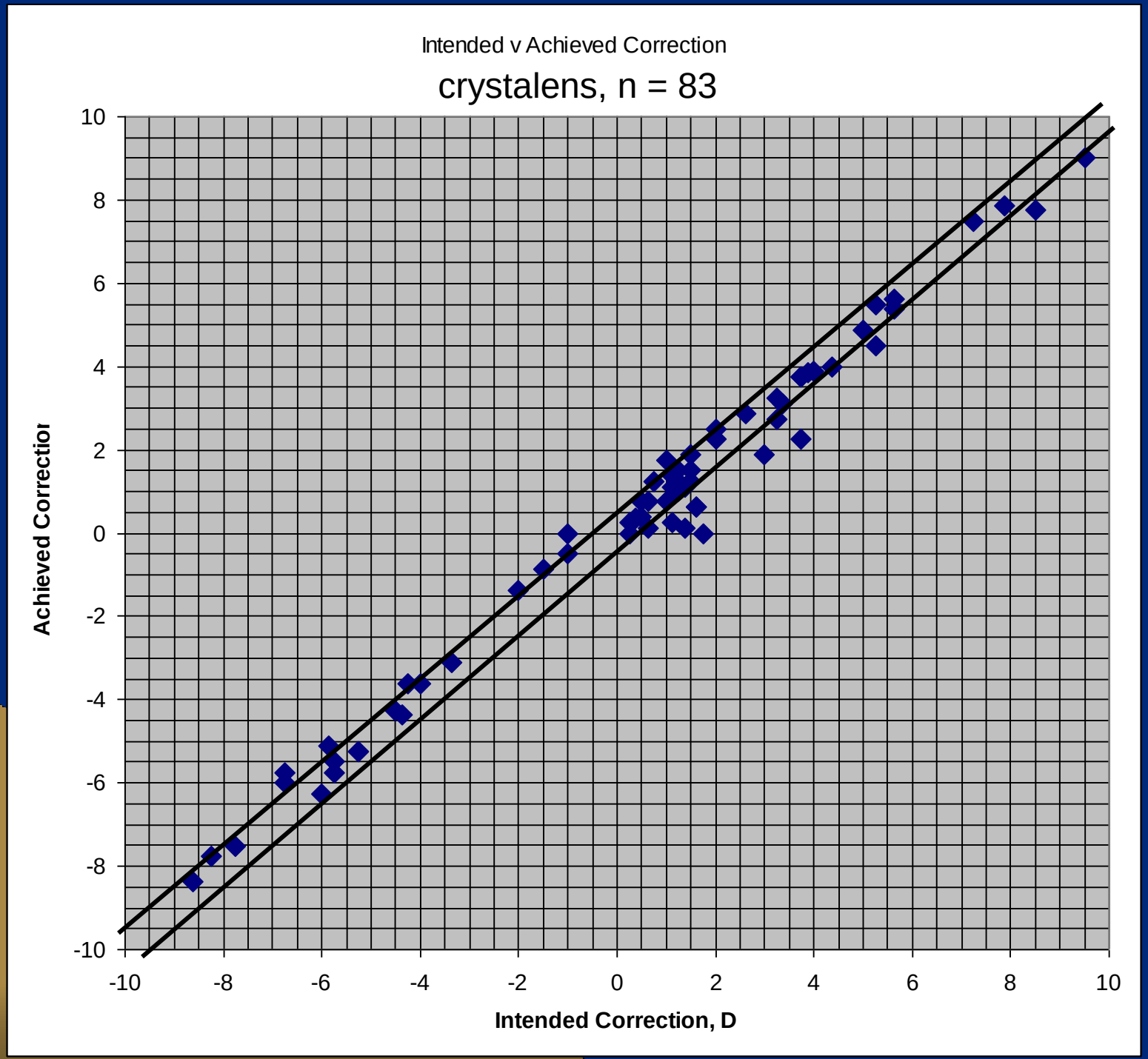

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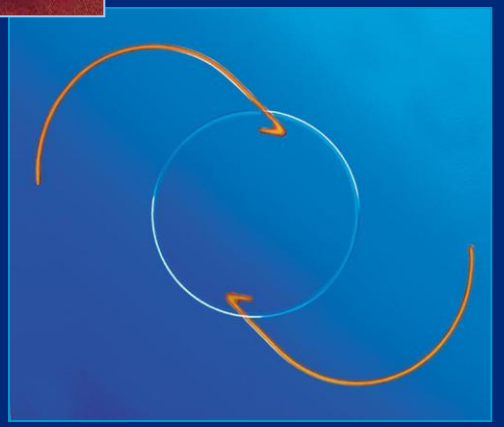
Refractive Enhancement

- PRK/L
  ASIK

- Piggyback
  IOL



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Piggyback IOLs

- AQ 5010, CLRFXB
- HolladayR
- 1 D ≈ 0.7 D Spectacle Plane

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HicSoapPro - Iol Calc Report

Report Date: 10/24/2005

Patient: **Sample, Example** ID: **pb-example** Date of Birth: **25-Oct-1953** Sex: **Female**

Pre-Op. Data

OD

Surgeon: **PACKER, MARK** **10/24/2005**

Refraction: **+1.50 +0.25 X 105** Axial Len: **21.00**

Vertex: **12.00** Adj. AL:

BCVA: **20/20** Hor W-t-W: **12.00**

UCVA: **20/50** Phakic ACD: **5.50**

K1: **44.25 @180** Phakic Lens Th.: **1.00**

K2: **45.00 @90** Target Ref: **0.00**

Average K: **44.63** Tgt Add: **0.00**

Adjusted K: **44.63**

OS

Surgeon: **PACKER, MARK** **10/24/2005**

Refraction: **+1.00 +0.75 X 60** Axial Len: **20.90**

Vertex: **12.00** Adj. AL:

BCVA: **20/20** Hor W-t-W: **12.00**

UCVA: **20/40** Phakic ACD: **5.60**

K1: **44.12 @165** Phakic Lens Th.: **1.00**

K2: **45.00 @75** Target Ref: **0.00**

Average K: **44.56** Tgt Add: **0.00**

Adjusted K: **44.56**

Additional Data

OD

Eye Status: **Pseudophakic** PreOp Pathology: **No**

New PC Lens: **in sulcus** Prev. Rk... : **No**

Keratoconus: **No**

Secondary Piggy-Back IOL Scleral Buckle: **No**

Silicone in Vitreous Cavity: **No**

OS

Eye Status: **Pseudophakic** PreOp Pathology: **No**

New PC Lens: **in sulcus** Prev. Rk... : **No**

Keratoconus: **No**

Secondary Piggy-Back IOL Scleral Buckle: **No**

Silicone in Vitreous Cavity: **No**

Formula: Holladay R

OD

Lens #1 **Staar-AQ-5010V**

Procedure: **Secondary PB**

MFG ACD: 5.55

IOL	Pred. Ref.
1.50	0.60
2.00	0.24
2.50	**-0.11**
3.00	-0.47
3.50	-0.83

Lens #2 **AMO-CLRFLXC**

Procedure: **Secondary PB**

MFG ACD: 4.97

IOL	Pred. Ref.
1.00	0.91
1.50	0.55
2.00	**0.18**
2.50	-0.19
3.00	-0.56

Formula: Holladay R

OS

Lens #1 **Staar-AQ-5010V**

Procedure: **Secondary PB**

MFG ACD: 5.55

IOL	Pred. Ref.
1.00	0.68
1.50	0.33
2.00	**-0.02**
2.50	-0.38
3.00	-0.75

Lens #2 **AMO-CLRFLXC**

Procedure: **Secondary PB**

MFG ACD: 4.97

IOL	Pred. Ref.
1.00	0.65
1.50	0.29
2.00	**-0.09**
2.50	-0.46
3.00	-0.84

IOL Consultant Notes

OD

The probability of this IOL is < 0.1%

The probability of the ACD occuring in the population is < 0.1%

The probability of the LT occuring in the population is < 0.1%

OS

The probability of the AXIAL LENGTH occuring in the population is < 4.6%

The probability of this IOL is < 0.1%

The probability of the ACD occuring in the population is < 0.1%

The probability of the LT occuring in the population is < 0.1%

Surgeon/Technician Notes

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Crystalens AT-45 RLE Piggybacks

- 15.7 % (13 of 83)
- Excluding planned primary or secondary piggybacks and post RK / LASIK eyes

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Piggyback Outcomes

- 13 eyes of 8 women, 2 men

- Pre Op RLE
  - UCDVA 20/280 (20/25 – 20/800)
  - BCVA 20/22 (20/15 – 20/40)
  - Mean SE +2.63 (+ 0.5 - + 9.5) D

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Piggyback Outcomes

- Post Op RLE
  - Mean UCDVA 20/52 (20/25 -20/200)
  - Mean UCNVA J 9.5 (J 1 – J 16)
  - Mean SE +1.14 (-2.5 - +3.0) D
- Post Op Piggyback
  - Mean UCDVA 20/23 (20/15 – 20/40)
  - Mean UCNVA J 3.6 (J 1 – J 10)
  - Mean SE + 0.1 (-0.6 - +0.4) D

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Piggyback IOL Considerations

- Residual astigmatism
- Anatomy
  - AC Depth
  - Capsulotomy
- Available powers
- Intraocular procedure
  - Cost
  - Risk

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Piggyback IOL Advantages

- Rapid rehabilitation
- Excellent predictability
- Familiar techniques
- No additional incisions
- No ocular surface issues
- No microkeratome/excimer

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Future Directions

- Post LASIK IOL Calculations
- Direct links to EMR
- Real time digital imaging & measurement

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Drivers of Satisfaction

- Meticulous surgical technique

PACKER BIMANUA
PHACO 2
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0.0 AVG
C/L
CONTINUOUS
BPS
0
cc/Min
Asp Rate
6
mmHg
Vacuum
0
%
Power

Thank You!