American Society of Cataract and Refractive Surgery

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Ernest N. Morial Convention Center

Course 08-107
Room 238-239

“Multifocal, Toric Multifocal and Accommodative IOL: Face The Challenge”

Senior Instructor:
Matteo Piovella MD

Instructor:
Jack T Holladay MD MSEE FACS
Richard L. Lindstrom MD
Jay S Pepose MD PhD
Richard Tipperman MD

Sunday, May 8, 2016
8:00 AM – 9:30 AM
INDEX

Overview on Presbyotic IOLs and Personal Experience with the AT LISA tri
Matteo Piovella MD

The Promise of No Glasses or Contact Lenses!
Jack T Holladay MD, MSEE, FACS

Can I Mix Different Multifocal IOLs or Multifocal With Monofocal IOLs?
Richard L. Lindstrom MD

How Do You Choose Between a Multifocal and an Accommodating IOL?
Jay S Pepose MD PhD

Multifocal IOL Pearls
Richard Tipperman MD

ADDRESESS
“Overview on Presbyotic IOLs and Personal Experience with the AT LISA tri”
Matteo Piovella MD

Overview on Presbyopic IOLs and Personal Experience with the AT LISA tri

Dr Piovella has the following financial interests or relationships to disclose.

As consultant:
- Aaren Scientific
- Abbott Medical Optics
- Allergan
- Carl Zeiss Meditec
- Tecnis

As lecturer fees:
- BVI Beaver Visitec International
- Cataract Society
- TearLab

Dr Kusa doesn’t have financial interests or relationships to disclose.

Financial Disclosure

Effect of Contrast Sensitivity Reduction

MTF (59 lp/mm) Sensitivity to IOL Rotation Error
Up to 2.0 D Cylinder Correction – Pupil Size 5 mm

MTF with Cylinder Cylinder Corrected

With Accommodative IOLs there is no loss of light, so quality of vision is not compromised.

Pupil

Synchrony

ReSTOR

TECNIS MF

Near

2 mm
100%
40%
41%

5 mm
100%
64%

Distance

2 mm
100%
40%
41%

5 mm
100%
10%

Intermediate

2 mm
100%
0%
0%

5 mm
100%
0%

Light Loss

2 mm
0%
0%
18%

5 mm
0%
0%
18%

Weak Points of Most Popular Multifocal IOLs
(Diffractive Bifocal Technology Limits)

- Reduction of Contrast Sensitivity (up to 20%)
- Small P.D. refractive errors may be critical: Postop. 0.69 diopter 6E generator loss of half line of Vision justifiy
- TORIC MULTIFOCAL OVER 0.75 D ASTIGMATISM
- Diffractive IOLs: Diffraction Grooves (Blaze height) Create Different Diffraction Efficiency and Light Loss
  - Halos, Glares and Glare images are difficult to manage in Suspective Patients
- Poor Intermediate Distance Vision
- Perfect Target: Plane Postop

Look for the Light and not to Look for Glasses!

Eye Surgeons have to select the Eye
We know better the Eyes than the Patients!

Best results with eyes that provide:

- Opportunity to apply high standard Biometry to get high precision results for IOL calculation
- Opportunity to get 20/20 vision after the surgery
- Opportunity to get emmetropia and normal stereopsis Postop
- Inform the Patients they have to:
  - look for the light and not to look for glasses

Modern History of Multifocal Bifocal, Trifocal
and Extended Depth of Focus IOLs
13 Years Developments

- Restor+ Bifocal IOL, Alcon 2004
- Restor+ Astigmatic Bifocal IOL, Alcon 2006
- ReZoom™ Bifocal IOL, AMO ABBOTT 2004
- TECNIS® Bifocal IOL, AMO ABBOTT 2006
- Restor+ Bifocal IOL, Alcon 2007
- Auris Bifocal IOL, Zeiss 2006
- Symfony: Accommodative IOL, AMO ABBOTT 2014
- Auris Toric Bifocal IOL, Zeiss 2016
- Centauro 2011
- Al Lisa Trifocal IOL, Zeiss 2010
- Restor 2.4 Bifocal IOL, Alcon 2014
- Al Lisa Trifocal Toric IOL, Zeiss 2013
- CMA - Visual Study Coordinator Centre (Centre n°1)
  - Symfony: Extended Depth of Focus IOL, AMO ABBOTT 2014
  - Panoptik: Trifocal IOL, Alcon 2016
  - IOL: Extended Depth of Focus IOL, Asfleece 2016

Diffractive Technology Provides Reduction of Contrast Sensitivity (up to 20%)
This Weak Point should be Easily Overcome by Increasing Light Efficiency
Inform the Patients they have to look for the light and not to look for glasses
The Easier, Faster, and More Efficient Way to Improve the Dim Light is to Use Smart Phones Torce Function. Every Patient has one immediately available.
Patients Like it and Thank You to Provide Simple and Perfect Solution

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  - IOL: Extended Depth of Focus IOL, Asfleece 2016

AT LISA® tri - Trifocal Optic
AT LISA® tri (Zeiss)
Specific Asymmetrical Light Distribution

The optimization of the AT LISA® tri IOL design provides
- a near addition of +0.35 D for a comfortable reading distance
- an intermediate addition of +1.66 D

It improves intermediate vision without compromising near or far vision.
AT LISA® tri has layerings on the IOL optics surface for reduced ocular visual disturbances and improved night vision.

AT LISA® tri IOL light-power

- AT LISA® tri: asymmetrical light distribution:
  - 30% near
  - 20% intermediate
  - 30% far

This technology decreases light loss

<table>
<thead>
<tr>
<th>% LIGHT DISTRIBUTION</th>
<th>LIGHT “LOSS”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near</td>
<td>Intermediate</td>
</tr>
<tr>
<td>30%</td>
<td>20%</td>
</tr>
</tbody>
</table>
AT LISA® tri
Materials and Methods

- AT LISA® tri implanted in 84 eyes of 58 patients
- Mean Age 67.02 ± 11.16
- Mean Preoperative BCVA 20/42 ± 45.87
- Mean Time Follow Up 2 years ± 1 month
- Mean Preoperative Sphere Equivalent -0.01 ± 3.08

AT LISA® tri (84 Eyes)
UDCVA - BCDVA and Sphere Equivalent (84 Eyes)

- AT LISA® tri implanted in 84 eyes of 58 patients
- 38 Eyes YAG laser treatments (31.95%)
- Mean days PO: 22.13 ± 21.18 days

AT LISA® tri (84 Eyes)
YAG LASER TREATMENTS

AT LISA® tri toric Materials and Methods

- AT LISA® tri toric implanted in 46 eyes of 41 patients
- Mean Age 66.97 ± 12.61
- Mean Preoperative BCVA 20/77 ± 12.17
- Mean Time Follow Up 2 year
- Mean Preoperative Sphere Equivalent -0.94 ± 3.12
- Mean Preoperative Corneal astigmatism 1.64 ± 0.65
- Mean Preoperative Refractive Astigmatism 0.92 ± 1.08

AT LISA® tri Toric
UDCVA - BCDVA and Sphere Equivalent (46 Eyes)
ATLisa® III toric 56 eyes
YAG LASER TREATMENTS

- ATLisa® III toric Implant in 66 eyes of 41 patients
- 8 Eyes : yag laser treatments (12.20%)
- Mean days: PO: 457.25 ± 111.74 days

Multifocal IOLs Contrast Sensitivity

Multifocal IOLs and Extended Depth Of Focus IOLs
New Regarded Bitonal Technology

Multifocal IOLs Limits:
- Too sensitive to Small Amount Post Operative Refractive Error
  (0.63 Dioptr PR Refractive Outlines is the limit for good patient compliance)
- No Intermediate Distance Vision Provided

Trifocal IOLs:
- Less Sensitive to Small Amount Post Operative Refractive Errors
- Provide Intermediate Distance Vision
- Best Available Refractive Near Vision Correction

Extended Depth Of Focus IOLs
- Independent from Small Amount Post Operative Refractive Errors
- Provide Intermediate Distance Vision

Trifocal IOLs:
- Improve Presbyopic IOLs Implantation over 50%

> Trifocal Technology has replaced Bitonal Technology
> Normally we are processing long term data that do not match the today technology
> Normally Eye Doctors that have enough direct experience on advanced technology IOLs make all these efforts and sometimes more than 2 years to understand their problems
> The Eye after advanced surgery needs at least three months to get back to standard quality of vision
> By the point of view of the patient's many complaints seem similar for monofocal and advanced technologies IOLs
> Adoption of new technologies takes time and is very expensive.

Biometry is a Key Point:
Refractive postoperative Goal:
  - Sphere equivalent within - 0.50 and +0.50

Monocular evaluation

Trifocal IOL 66 eyes
- 21.88
- 78.12
- IN
- OUT

Toric Trifocal IOL 66 eyes
- 18.46
- 81.54
- IN
- OUT

IOL MASTER 700
How many patients have 1 or both eyes in the "right range"?
-0.30dph / +0.30dph

87 BILATERAL IMPLANT

IN ONE EYE

OUT BOTH EYES

IN BOTH EYES

83% OF PATIENTS IN THE RIGHT RANGE

VARIABLE LIGHT ENERGY DISTRIBUTION WITH RESPECT TO THE PUPIL Ø

AT LISA TRI TORIC

FINENEVISION B&L

Why I Decided to Implant Zeiss AT LISA® tri in my Eyes?
73.9% of my Catract Patients (2015)
were implanted with Trifocal IOLs

I started to implant modern multifocal IOLs routinely in 2009
In 2015 in our center 73.9% of our patients were implanted with Trifocal IOLs
52.11% Trifocal Tento

Today Intraocular advanced technology has replaced standard Multifocal (bi-foal)
technology because provides Intermediate distance
Zeiss AT LISA® tri is our first and standard device for presbyopia correction since its introduction
Our center is the leader in surgical complications for Multifocal IOLs and the use of Zeiss Trifocal IOLs
I am an International recognized surgeon and I had in my practice for long time to perform eye surgery

Trifocal IOLs Decentration

Right Eye UFVVA 2020
UC/NVI J3
Personal Dysfunctional Lens Syndrome Management

Why I Decided to Adopt FLACS for My Eyes

> It is well known that the highest rate of complications is due to Capsulectomy weakness.
> In February 2014 I have visited Burkhard Dick in Bochum Center. He performed a FLACS, with only one surgical step, within 2 hours and was assisted only by a nurse and one assistant.
> I have used the AMO Catalys Femtolas 15 months before having treated my eyes.
> Burkhard Dick was the Medical Director for AMO Catalys and at that time he had upgraded the machine with more that 6 advanced options.
> The efficiency of AMO Catalys related to capsulorhexis is outstanding.

Right Eye had Retinal Detachment Laser Treatment in October 2016
No of 3 retinal holes. Under the Expertise Reiner Wunzler.
Relative Off Three Papillary Diameters

Surgical Plan

AMO Catalys Femtolas Assisted Cataract Surgery
Zeiss AT LISA Tri IOL Implantation

Right Eye
Left Eye

AT LISA tri
AT LISA tri toric

+10.00 D
+9.50 +1.50 axis 71 D

Surgeon: Burkhard Dick - Bochum - Germany

One Year Postoperative Results
July 04, 2014 - July 2015

Right Eye
Left Eye

UCVF 20/12.5
UCVF 20/20

Binocular UCFV 20/12.5
Binocular UCV 20/12 (Bright Light)
Binocular UCNV 20/20 (Bright Light)

# Catalys Femtolas Assisted Cataract Surgery
#s AT LISA Tri IOL Implantation
Surgeon: Burkhard Dick - Bochum - Germany
Six Months PO Unoculear VA Results
40 eyes of 20 patients

Six Months BInoculear VA Results
20 Patients

Detocus Curve

3 Months PO
IOL decentration

- Test performed with both eyes with manifest refraction
- Detocus the image from +0.50 to -0.50
- Far Visual Acuity 52/20 range -1.00 to -2.00

Surgical Complication
IOL Decentration Needs an Effective Management
Barr tert within the First Postoperative Month

Incision size and water tight properties

IOL Repositioning
1 week post repositioning

BCVA 20/20 - 2.00 sph
### Summary

**Eyes Selection**

Look for the Light and not to Look for Glasses!

- Possibility to perform high standard Biometry to get high precision results for IOL calculation
- Possibility to get 20/20 vision after the surgery
- Possibility to get emmetropia postoperatively
- Inform the Patients they have to look for the light and not for glasses

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**Post YAG Laser Treatment**

Thank you for your attention
The Promise of No Glasses or Contact Lenses!

Jack T. Holladay MD, MSEE, FACS
Optimizing intraocular lens power calculations in eyes with axial lengths above 25.0 mm

- Li Wang, MD, PhD, Master/PhD, MSc, Senior Associate Editor, Journal of Ophthalmic Surgery, Department of Ophthalmology, University of Southern California, CA, USA

**Article**

**Abstract**

To improve the accuracy of intraocular lens power calculation in eyes with axial length (AL) greater than 25.0 mm, a new method of optimizing AL is proposed and evaluated.

**Methods**

A novel method of optimizing AL is proposed and evaluated in a group of patients. The method involves the use of a novel formula and is shown to be superior to traditional methods in improving the accuracy of AL optimization.

**Results**

The new method of optimizing AL was shown to be significantly more accurate than traditional methods, with a mean improvement of 0.8 mm.

**Conclusion**

The new method of optimizing AL is a significant improvement over traditional methods, and should be considered for use in cases with AL greater than 25.0 mm.

**Keywords**

- Intraocular lens
- Axial length
- Optimization
- Accuracy

---

**Requirements**

- Accurate Biometry – IOL Master
- Accurate K’s – Repeatable
- 4th Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism
IOL Power Calculations

- Pentacam can measure FRONT & BACK SURFACE POWER
- Can Calculate:
  - Equivalent K-Reading (EKR)
  - 65% Mean, Peak & Average
  - NET POWER

EKR

- Reports Keratometry value but adjusts for Back Surface Power from Normal (Current IOL Formulas)
- If corneal front surface is 7.5 mm (45 D), but if back surface -0.3 D > normal:
  \[ EKR = 45.0 - 0.3 = 44.7 \text{ D} \]
  \[ \text{Note: Net Power = 43.3 D} \]

New algorithm for intraocular lens power calculations after myopic laser in situ keratomileusis based on rotating Scheimpflug camera data

Holladay Report

Equivalent K-Reading

IOL Calcs – Abnormal Cornea
(Use 65% MEAN EKR)

- Post Refractive Surgery
- Post PKP
- Keratoconus
- Corneal Scar
- Any Irregular Astigmatism
Use **65% Mean EKR** (@ 4.5, 4 & 3 mm zones)

**Normal**
- 41 to 44 D
- 3 D Range

**LASIK**
- 36 to 41 D
- 5 D Range

**RK**
- 32 to 45 D
- 13 D Range

**POST LASIK**

**Post LASIK CALC**
- $K_{\text{mean}} = 39.8 \text{ D}$
- Used 39.8 D => $\text{SEQ} = +1.12 \text{ D}$
  
  $\left( +1.00 + 0.25 \times 155 = 20/20 \right)$
- 65% mean = 38.8 D => +0.12 D

**Use 65% mean K**

**Conclusions**

- EKR – Use 65% Mean for all IOL Calcs
- Look @ smaller zones than 4.5 mm if pupil very small
  
  (< 3.0 mm in dim light)

**Requirements**

- Accurate Biometry – IOL Master
- Accurate K’s- Repeatable
- **4th** Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism
**Vergence Formula**

\[ IOL = \frac{1336}{AL - ELP} - \frac{1336}{ELP} = \frac{-1336}{1000} + K(\text{Post } R) \]

\[ \text{DPostRx} \]

---

**CONCLUSION: 9 EYES**

<table>
<thead>
<tr>
<th>Anterior Segment Size</th>
<th>Megastromas</th>
<th>Megastromes</th>
<th>Large Eye</th>
<th>Dystrophomes</th>
<th>Microcornea</th>
<th>Axial Myopes</th>
<th>Axial Hyperopes</th>
<th>Axial Achromatops</th>
<th>Axial Astigmatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>(2%)</td>
<td>(6%)</td>
<td>(2%)</td>
<td>(2%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(80%)</td>
<td>(20%)</td>
<td>(2%)</td>
</tr>
<tr>
<td>Normal</td>
<td>(2%)</td>
<td>(4%)</td>
<td>(2%)</td>
<td>(4%)</td>
<td>(60%)</td>
<td>(60%)</td>
<td>(20%)</td>
<td>(20%)</td>
<td>(20%)</td>
</tr>
<tr>
<td>Small</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
<td>(10%)</td>
</tr>
</tbody>
</table>

**Axial Length**

- Short
- Normal
- Long

---

**Measurements taken for Predictors of ELP**

- Axial Length
- Average K (Pre Ref)
- Horizontal WTW
- ACD
- LT
- Pre-op Refraction
- Age

---

**FORMULA PERFORMANCE**

<table>
<thead>
<tr>
<th>Mean Absolute Error (mm)</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial Length (mm)</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Holladay 1
- SRKT
- Holladay 2

**Requirements**

- Accurate Biometry – IOL Master
- Accurate K’s – Repeatable
- 4th Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism
**Personalized Lens Constant**
- Never use Manufacturer's Constant except to start
- 20 to 40 cases and continue
- Factors
  - IOL Style
  - Lens placement
  - Post op medications
  - Biometer, keratometer, ...

**Requirements**
- Accurate Biometry – IOL Master
- Accurate K’s – Repeatable
- 4th Generation Formula (WTW)
- Personalized Lens Constant
- Eliminate Corneal Astigmatism

**TORIC IOL Calculations**
- Commercial Calculators use a constant ratio (1.46) for the corneal cylinder to the IOL cylinder
- Exact Calculation depends on IOL SEQ Power and ELP... to correct 2D of corneal astigmatism
  - 10 D IOL = 3.3 D Cylinder
  - 22 D IOL = 2.9 D Cylinder
  - 34 D IOL = 2.4 D Cylinder

A 1.1 D difference from 10 D to 34 D!

**Toric Optimization**

<table>
<thead>
<tr>
<th>Measured Data</th>
<th>Calculated Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOL Toricity X</td>
<td>1.47 0.0 0.8</td>
</tr>
<tr>
<td>Axis 35°</td>
<td>-0.85 +1.03 X35°</td>
</tr>
<tr>
<td>Measured Data</td>
<td>Calculated Data</td>
</tr>
<tr>
<td>IOL Toricity Y</td>
<td>43.87 045°</td>
</tr>
<tr>
<td>Axis 45°</td>
<td>-0.86 +1.13 X45°</td>
</tr>
</tbody>
</table>
PREOP 6 D Toric IOL

PREOP 6 D Toric IOL – OD

PREOP 6 D Toric IOL – OS

Thank You!
“Can I mix different Multifocal IOLs or Multifocal with Monofocal IOLs?”

Richard L Lindstrom MD

Curbside Consultation in Cataract Surgery
Submitted by Richard L. Lindstrom, M.D.
Founder: Minnesota Eye Consultants, P.A.
Adjunct Professor Emeritus: University of Minnesota
Department of Ophthalmology

Q. Can I mix different multifocal IOLs or multifocal with monofocal IOLs?
Multifocal intraocular lenses and accommodating intraocular lenses can be paired with a normal crystalline lens in the opposite eye, a monofocal implant in the opposite eye or a different multifocal or accommodating lens in the opposite eye. Combining complementary intraocular lenses provides for many patients a superior outcome to that achieved utilizing the same implant in both eyes. The concept of using different optical systems in each of a patient’s two eyes which are complimentary is not new. The most common example of this, familiar to all ophthalmologists, is monovision where one eye is set for distance and the other for near. If the difference between the two eyes is greater than 1.50 diopters I call that monovision and if it is less than 1.5 diopters I call it blended vision. In blended vision some stereopsis and fusion is retained and a relative amblyopia for distance is less likely. In the case of multifocal and accommodating lenses there are at least 10 potential options which can be utilized. An accommodating lens can be implanted into one eye with a normal crystalline lens in the opposite eye. A multifocal lens can be implanted into one eye with a normal crystalline lens in the other eye. Bilateral accommodating intraocular lenses can be utilized with a symmetrical refractive outcome target. Bilateral accommodating intraocular lens can be utilized with a blended vision outcome (targeting for example -0.25 diopters in one eye and -1.00 diopters in the alternate eye.) Bilateral multifocal implants with the same optical configuration can be implanted in both eyes with a symmetrical refractive outcome target. Bilateral multifocal implants with the same optical configuration can be utilized with a blended vision outcome (targeting for example plano in one eye and -0.50 diopter in the alternate eye). An accommodating intraocular lens can be implanted in one eye and a monofocal implant in the opposite eye. A multifocal intraocular lens can be implanted in one eye and the monofocal lens in the opposite eye. An accommodating intraocular lens can be implanted in one eye and a multifocal lens in the opposite eye. Complimentary multifocal intraocular lenses can be implanted in the alternate eyes. For example a zonal aspheric intraocular multifocal intraocular lens (ReZoom) in one eye and an epodized defractive/refractive multifocal intraocular lens in the opposite eye (ReStor). This has become known as “mix and match” of presbyopia correcting intraocular lenses. To best use complimentary intraocular lenses it is important for the ophthalmologist to understand the strengths and weaknesses of each intraocular lens. The standard monofocal intraocular lens is the best economic value. It gives excellent distance, fair intermediate and poor near vision. For example 20/20+, J4, J7 at the three distances. The pseudo-accommodative amplitude is approximately 2 diopters which means it has about 1 diopter of pseudo-accommodative amplitude to the minus side. This means that if the patient is targeted for a -1.50 refractive outcome they will be able to
read as though they had a +2.00 to +2.50 reader. The lens has positive spherical aberration of approximately +0.10 microns, somewhat dependent on optic power and optic design. This type of spherical aberration is best in patients who have negative spherical aberrations in the cornea such as those post-hyperopic LASIK, with keratoconus or a cornea with naturally occurring negative spherical aberration (10-20%). Second, we have aspheric monofocal intraocular lenses including those with no spherical aberration (B & L Advanced Optic) and those with negative spherical aberration (AMO Tecnis, Alcon IQ). The intraocular lens with no spherical aberration is most forgiving of decentration and tilt, and might be selected in patients where decentration might occur such as in pseudoexfoliation, a capsular tear or where an ideal capsulorhexis is not available. The implants with negative spherical aberration give better quality of vision, especially mesopic vision in the patient with a typical cornea with positive spherical aberration. They also provide superior performance in the patient that has undergone myopic refractive surgery. The accommodating intraocular lens as designed by Eyeonics and called the Crystalen gives excellent distance and intermediate vision. Typically one can achieve 20/20+ and J1 at distance and intermediate respectively. It provides good near acuity with a typical outcome being J3 or better. This lens has the least night vision symptoms, the least loss of contrast sensitivity and the least color distortion of all presbyopia correcting intraocular lenses. It is also pupil size independent in its optical function. It is excellent for blended vision. The zonal aspheric multifocal intraocular lens manufactured by AMO and called the ReZoom provides good distance acuity, good intermediate acuity, and good near acuity. Typical outcomes are 20/20 distance, J2 intermediate and J2 at near. There are some night vision symptoms, some loss of contrast sensitivity and some color distortion. This lens is pupil size dependent. The aspheric diffractive multifocal intraocular lens (AMO Tecnis Diffractive Multifocal Intraocular Lens) provides good distance acuity, fair intermediate and excellent near acuity. Typical outcomes to be expected are 20/20- at distance, J4 at intermediate and J1 at near. It also has the potential for night vision symptoms, decreased contrast sensitivity and some color distortion. The decreased contrast sensitivity usually associated with a multifocal implant is reduced by the aspheric nature of the optic. This lens is not pupil size dependent. The epodized diffractive/refractive multifocal intraocular lens (Alcon ReStor) provides good distance acuity, fair intermediate and excellent near acuity. Distance acuity might be expected to be 20/20-, intermediate J4 and near J1. This lens also potentially generates night vision symptoms, decreased contrast sensitivity and color distortion. It is also pupil size dependent as the lens becomes more distance dominant as the pupil dilates. The author and other members of his practice (Minnesota Eye Consultants, P.A.) have utilized all of the above combinations of implants with good success. Multifocal intraocular lenses have been used in a mix and match approach for approximately 20 years, beginning in 1985. Our experience has been that almost all patients adapt well over time to the use of complimentary optics in their alternate eyes. Neuroadaptation is a concept that is receiving increased attention as ophthalmologists use more and more optical systems dissimilar to the natural crystalline lens. It appears that there is an early and late neuroadaptation. Approximately 80 percent of patients seem to adapt easily to complimentary optics whereas 20 percent may struggle for a few months to a year or more. Late neuroadaptation appears to occur at near 100 percent and the author’s personal experience is that there are no patients in his practice with over 2 years follow-up with dissimilar optics who have not adapted well to their optical system. Select recent clinical series of mix and match with some multifocal and accommodating intraocular lenses provide insight into the outcomes that might be obtained. Leonardo Akaishi, MD and Pedro Paulo Fabri, from Sao Paulo, Brazil have performed a comparative series of ReZoom/ReZoom, ReStor/ReStor, ReZoom/ReStor and Tecnis Diffractive/ReZoom. Their outcomes are summarized in Table 1. The best outcomes were obtained with ReZoom/Restor and ReZoom/Tecnis Diffractive Intraocular Lens combinations.
Rick Milne, MD from Columbia, South Carolina has also performed a comparative series looking at patient satisfaction, spectacle independence and daytime and nighttime halo. His outcomes are summarized in Table 2. Again, the ReZoom/ReStor outcomes generated higher patient satisfaction than the ReStor/ReStor outcomes in this series.

<table>
<thead>
<tr>
<th></th>
<th>ReZoom/ReZoom (N=100)</th>
<th>ReStor/ReStor (N=100)</th>
<th>ReZoom/ReStor (N=88)</th>
<th>ReZoom/Tecnis Diffractive (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral uncorrected distance</td>
<td>20/20</td>
<td>20/25</td>
<td>20/20</td>
<td>20/20</td>
</tr>
<tr>
<td>Bilateral uncorrected intermediate</td>
<td>J2.15</td>
<td>J3.85</td>
<td>J2.30</td>
<td>J2.10</td>
</tr>
<tr>
<td>Bilateral uncorrected near</td>
<td>J2.30</td>
<td>J1.40</td>
<td>J1.50</td>
<td>J1.10</td>
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<tr>
<td>Average reading speed (words per minute)</td>
<td>125</td>
<td>165</td>
<td>155</td>
<td>185</td>
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<td>Spectacle independence</td>
<td>75%</td>
<td>89%</td>
<td>100%</td>
<td>100%</td>
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<tr>
<td>Halos/glare</td>
<td>2+</td>
<td>1+</td>
<td>1+</td>
<td>1-</td>
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<tr>
<td>MTF</td>
<td>0.20</td>
<td>0.12</td>
<td>0.18</td>
<td>0.38</td>
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Frank A. Bucci, Jr. MD from Wilkes-Barre, Pennsylvania has also completed a series comparing ReStor/ReStor to ReZoom/ReZoom. His outcomes are summarized in Table 3. Of note, is that his intermediate vision outcomes are significantly better with ReZoom/ReStor than with ReStor/ReStor and that his patient satisfaction is also higher.
Finally, Trevor Woodhams, MD from Atlanta, Georgia has a series of patients with Crystalens/ReStor use in alternate eyes. Again, he found excellent distance, intermediate and near vision with high patient satisfaction.

<table>
<thead>
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<th>Unhappy with intermediate</th>
<th>32%</th>
<th>0%</th>
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<table>
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<tr>
<th>Bilateral uncorrected intermediate</th>
<th>J3.81</th>
<th>J2.39</th>
<th>(P=.001)</th>
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<tr>
<td>Bilateral uncorrected near</td>
<td>J1.00</td>
<td>J1.04</td>
<td>(P=NS)</td>
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In summary, the human visual system can neuroadapt to dissimilar optics in alternate eyes. Patients should be given at least one year to neuroadapt to their new optical system before explant/exchange is considered. Multifocal or accommodating intraocular lenses can be used successfully with a monofocal intraocular lens in the opposite eye. Multifocal or accommodating intraocular lenses can also be used successfully with a natural crystalline lens in the opposite eye. Of great importance is the observation that complimentary multifocal and accommodating intraocular lenses may provide superior outcomes for many patients than symmetrical implantation of the same intraocular lens in both eyes, especially at intermediate distance. Further clinical study is ongoing but the current evidence supports the use of complimentary presbyopia correcting intraocular lenses in the alternate eyes of select patients.
“How Do You Choose Between a Multifocal and an Accommodating IOL?”

Jay S. Pepose MD, Ph.D

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An Iterative, 3 Step Process

There are 3 essential steps that help guide the ophthalmologist in advising patients who are deciding between accommodating and multifocal IOL options. This premium group of lens implants has sometimes been referred to as “lifestyle IOLs”. Appropriately, the first step in the decision tree is taking the time to understand each individual’s lifestyle, functional needs, and expectations.

Each presbyopia-correcting IOL has inherent strengths and weaknesses. IOL design features that achieve an expanded through-focus often are counterbalanced by some limitations or unwanted side effects. Understanding the inherent optical performance of each specific accommodating or multifocal IOL and balancing this with the patient’s lifestyle and visual priorities is the second critical step in this iterative process.

The final step in the determination is appreciating each individual’s distinctive ocular traits and characteristics that may impact the performance of an IOL in that individual. Examples of this step include evaluating pupil size, shape and dynamics, corneal wavefront, angle kappa, and macular status.

Step1: Understanding the Patient’s Lifestyle and Shaping Their Expectations

Every refractive lens surgeon understands that there is no pseudophakos that mimics the elegant fusion of form and function of an 18 year old’s crystalline lens. While with time we have seen iterative improvements in accommodating and multifocal IOL design, empathizing with the patient that unfortunately there is no “perfect” man-made substitute for the lens they were given by their creator aligns you with the patient as their honest advisor and advocate. Starting out by sharing this simple but important acknowledgement of the limitations of current IOL technology in comparison to the youthful crystalline lens goes a long way towards setting the stage for realistic expectations, the need for some compromise with either a multifocal or accommodating IOL, along with our inability to promise or guarantee total spectacle independence at all object vergences and lighting conditions. Within this framework, a very important part of the decision between a specific multifocal versus accommodating IOL is dependent on the patient’s lifestyle, visual needs and expectations, which can best be assessed with a series of open ended and directed questions.

Patients should be required to serially rank in order and priority their desire for optimized uncorrected distance, intermediate and near vision. While everyone would naturally want “perfect” vision at all vergences and almost everyone would be dissatisfied without good uncorrected distance vision, the patient should be asked if they frequently use computer, smart phones or perform other intermediate tasks. With regard to near vision, does the patient enjoy knitting or fly fishing or have other particularly close visual
needs? Given their body habitus, how close do they hold things when reading? Would the patient consider the need for reading glasses for smaller print a failure of IOL implantation? Does the patient frequently drive after it becomes dark? Note that the way this question is posed is important in that the patient may initially state that they do little “night driving” until reminded that it is dark as early as 5PM in the fall. Would some degree of halos around point sources of light at night be an acceptable or completely unacceptable exchange for improved uncorrected near vision? Is the patient currently emmetropic, hyperopic or myopic and how does this impact their post-operative expectations of uncorrected vision at various distances given their current status? In the next section, we see how the answers to these questions brings the doctor to the second step in optimizing the selection of the multifocal or accommodating IOL to best meet each patient’s needs.

**Step 2: Matching the Patient’s Visual Needs to IOL Performance, Limitations and Side Effects**

Clinical and optical bench studies both demonstrate important differences in the performance of accommodating versus specific multifocal IOL at various vergences\(^1,2\). A randomized, prospective study of patients randomized to bilateral implantation of the Crystalens AO (Bausch + Lomb) versus ReSTOR 3.0 (Alcon Laboratories) versus Tecnis multifocal IOL (Abbott Medical Optics) demonstrated that patients implanted with Crystalens achieved a better uncorrected and best corrected intermediate vision at 32 inches (~81 cm) compared to either multifocal\(^3\). In contrast to the accommodating IOL, patients implanted with either multifocal achieved better uncorrected and best corrected near vision. The near focal point of the Tecnis multifocal (~31-33cm)\(^4,5\) is closer than the ReSTOR 3.0 (~37cm)\(^6\), as the Tecnis has a 4.0D add as compared to the ReSTOR’s 3.0D add at the IOL plane. However, since the diffractive elements on the Tecnis are on the posterior surface of the IOL in contrast to the ReSTOR apodized rings on the anterior surface, this serves to push the Tecnis’ near point further out than the near point on the ReSTOR 4.0 (~31cm), yet closer than the ReSTOR 3.0. Objective and subjective tests of glare and halos show that these are greater with the Tecnis than the ReSTOR and least with Crystalens AO\(^3\).

**Step 3: Matching the Patient’s Ocular Traits and Characteristics to Specific IOL Performance**

The performance of both accommodating and multifocal IOLs depends upon a number of factors. Residual defocus and astigmatism impacts the function of all IOLs, but comparative clinical and bench studies have shown that both distance and near vision is generally more affected in patients with multifocal IOLs with 0.75D or more of residual astigmatism\(^2\). Similarly, image quality in eyes implanted with multifocal IOLs is adversely affected by high degrees of higher order aberrations, such as coma and spherical aberration. A number of topographers and combined topography/wavefront systems are capable of assessing the corneal wavefront preoperatively. Patients with greater than 0.3 microns of vertical or horizontal coma at a 6 mm optical zone may not be ideal candidates for multifocal IOLs (Figure 1) as this may be associated with glare, waxy vision and reduced image quality.
Figure 1. Metrics of horizontal and vertical coma, spherical aberration and other higher order aberrations are readily quantified in this Zernike decomposition of the corneal wavefront at a 6 mm zone performed using a Zeiss Atlas topographer.

The performance of apodized diffractive IOLs like ReSTOR is very dependent on changes in pupil size to shift light energy from near to far foci. It is important to assess pupil size, shape and dynamics preoperatively (Figure 2), in that patients with small, miotic, poorly reactive pupils in both mesopic and photopic conditions may have light energy chronically shifted towards near foci and elicit a waxy distance image quality. Conversely, patients with very large pupils that do not constrict well on accommodation, may not achieve the near vision that they are seeking with a ReSTOR multifocal. Whereas the Tecnis multifocal splits light evenly between near and far at all pupil diameters and may thereby allow reading vision even in lower illumination, studies have shown that intermediate vision is worse in patients with the Tecnis IOL with pupils ≥4mm compared to those with smaller pupils.⁴,⁵
Figure 2. The same topography unit also quantifies the pupil diameter and shows its shape under mesopic and photopic conditions.

Angle kappa is defined clinically as the angular distance in object space between the line of sight (i.e., line connecting the pupillary center and the fixation point) and the pupillary axis (i.e., the line passing through the center of the pupil perpendicular to the cornea). A prospective study of patients with refractive multifocal IOLs showed that patients’ complaints of glare and halos were positively correlated with preoperative values of angle kappa. One explanation for this observation is that if angle kappa is greater than half the diameter of the central optical zone of a multifocal IOL, the primary path of light may traverse one of the multifocal rings instead of the central optic leading to glare. The ReSTOR 3.0 IOL has a central optical zone of 0.8 mm and the Tecnis MF has a central optical zone of 1 mm. As a reasonable referent value, it may be that an angle kappa of less than 0.4 mm for ReSTOR 3.0 and 0.5 mm for Tecnis MF would greatly lessen the chances of the primary ray traversing the diffractive ring.

Since multifocal IOLs may, in some patients, reduce contrast sensitivity since the light energy is split between near and distance images simultaneously cast on the retina, patients with other independent reasons to have reduced contrast sensitivity may not be ideal candidates for multifocal IOLs. For example, contrast sensitivity may be reduced in patients with current co-morbidities such as epiretinal membranes, macular degeneration, myopic degeneration, diabetic retinopathy, dry eye disease and glaucoma or in individuals who develop these conditions in the future with aging. In comparison, accommodating IOLs have not been shown to reduce contrast sensitivity when compared to aspheric monofocal control IOLs.
Integrating the Results of the 3 Step Process in Surgical Planning

The final recommendation between a specific multifocal or accommodating IOL involves integrating and synthesizing all of the information that has been accumulated. For example, patients who do little night driving and whose main interests are knitting and watching television may be ideally suited for a Tecnis multifocal IOL, if they can accept the possibility of some halos and night glare which may diminish somewhat with neuro-adaptation over the course of months. Patients who work in low lighting conditions, such as a waiter in a low-lit restaurant or an x-ray technologist or someone who hunts at dusk, may not achieve adequate near vision with a ReSTOR IOL and may not be accepting of photic phenomenon or night glare with a Tecnis or ReSTOR. Such a patient might be offered a CrystaLens accommodating IOL with some degree of myopic offset of the non-dominant eye up to around -0.75D, with the warning that they may still require reading glasses. Patients with 4 mm mesopic pupils that react briskly to accommodation and who spend a lot of time on computer and also read a lot may find the Tecnis IOL to give a closer near point than their computer monitor (requiring them to move the screen closer or use low add readers) and may be better candidates for either a ReSTOR 3.0 or CrystaLens with a myopic offset of the non-dominant eye to mini-monovision. Listening to each patient’s needs, appropriately modifying their expectations, and assessing their ocular traits allows the ophthalmologist to synthesize this information and to use the aforementioned framework as a decision tree in choosing between a multifocal and accommodating IOL.

References

“Multifocal IOL Pearls”
Richard Tipperman MD

Which Eye To Operate On First

There are many different paradigms as to which eye to operate on first. These include: dominant or non-dominant eye first, poorer seeing eye first, etc.

My pearl is to operate on the least astigmatic eye first as this will maximize patient satisfaction and minimize the potential for enhancements or retreatments. For example, consider a patient w/.75 D of cylinder in one eye and 1.75 D of cylinder in the fellow eye. If you operate on the eye w/ 1.75D of cylinder first and do Iris there is a reasonable good chance you will hit your target refraction but it is also quite possible to have enough residual cylinder so that the patient is not happy w/ their uncorrected vision. In this case they will often not let you proceed w/ the fellow eye until you “touch up” and make the first eye better.

If however you operate on the eye w/.75D of cylinder first it is much more likely you will hit your target refraction and much more likely there will be any residual cylinder. Therefore the likelihood of needing to do an enhancement is much less. In this cases the patient is anxious and happy to proceed w/ surgery in their fellow eye. When you operate on the eye w/ 1.75D of cylinder even if you do not hit plano and eliminate all of their astigmatism they will often still be happy since their first eye is so good it can carry the visual function bilaterally. This will therefore minimize the potential for need for retreatment of residual cylinder.

Pharmacologic Therapy With ReSTOR IOLs

For the rare patients with reading difficulty following ReSTOR implantation weak pilocarpine will significantly improve the near abilities by constricting the pupil and forcing light through the central apodized portion of the IOL
For patients w/ night time dysphotopsia they will often have improvement w/ use of a mild mydriatic agent (0.5% tropicamide). This allows the pupil to dilate wide enough so that more light can go through the peripheral pure refractive portion of the IOL which is distance dominant and allows the distance image to dominate the near image and can significantly reduce the night time dysphotopsia.

Capsulorhexis Sizing

Brief clinical case presentation of patient w/ capsule contraction w/ ReSTOR IOL and poor vision. Marked improvement once anterior releasing capsulotomy done.
Explaination why rhexis sizing critical for multifocal IOLs based on energy distribution.
Pearls for sizing rhexis using RK marker and iris edge as landmarks

Pearls For Communicating With Your Patients

Pre and Post-Op

Why “undersell and overdeliver” is a confusing concept for your patients and your office staff – and how “educate and manage expectations” is a better approach.
Avoiding TMI Syndrome (Too Much Information): How to keep the education process short and simple.
Understanding the patient’s decision to proceed with presbyopic IOLs – Key phrases that help the patient quickly realize the benefits and elect to proceed with presbyopic IOLs.
Understanding the difference between a post-operative observation and a complaint and how this helps the post-operative management.
The right way and the wrong way to respond to patients perceived or real issues with their visual function.
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31