American Society of Cataract and Refractive Surgery

25-29 April, 2014
Boston, Massachusetts
Boston Convention Centre

Course 27-311 BCEC
Room 206 AB

“Best of the Best : Update on Advanced Cataract Surgery ”

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Instructor:
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Stephen S Lane MD
Matteo Piovella MD
Roger F Steinert MD
Steve C Schallhorn MD

Sunday, April 27, 2014
1.00 PM – 2.30 PM
# Index

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifocal, Accomodative and Toric IOL Implantation</td>
<td>3</td>
</tr>
<tr>
<td>In Advance Cataract Surgery</td>
<td></td>
</tr>
<tr>
<td>Matteo Piovella MD, Barbara Kusa MD</td>
<td></td>
</tr>
<tr>
<td>Multifocal IOL</td>
<td>16</td>
</tr>
<tr>
<td>Eric D. Donnenfeld MD</td>
<td></td>
</tr>
<tr>
<td>Option for Secondary Posterior Chamber IOLs: Scleral Tunnel with Glue</td>
<td>18</td>
</tr>
<tr>
<td>Roger F Steinert MD</td>
<td></td>
</tr>
<tr>
<td>Preliminary Results of Intrastromal Femtosecond Astigmatism keratotomy</td>
<td>22</td>
</tr>
<tr>
<td>Steve Schallhorn MD</td>
<td></td>
</tr>
<tr>
<td>ADDRESSES</td>
<td>25</td>
</tr>
</tbody>
</table>


“Multifocal, Accomodative and Toric IOL Implantation In Advanced Cataract Surgery”

Matteo Piovella MD & Barbara Kusa MD

Multifocal IOLs: Directions to Improve Patient Satisfaction

Dr. Piovella has the following financial interests or relationships to disclose:
- Abbott Medical Optics
- Alcon
- Carl Zeiss Meditec

Dr. Kusa has no financial interests or relationships to disclose.

Quality of Vision
Effect of Contrast Reduction

Rays and Wavefront

The key advantage of Wavefront over Rays is that the wave nature of light can be introduced with the Wavefront and then the image is formed by constructive interference of the light waves.

Wavefront Error is commonly called Wavefront

Wavefront Error $W(x, y)$ is defined as the difference between the actual wavefront $W_t(x, y)$ and spherical wavefront, so called Reference wavefront $W_{REF}$.

Testing for Through Focus MTF

Translating stage of the MTF test system is used to find Best Focus position and measure Through Focus image quality called Through Focus Response (TFR) Testing.
Pupil Size and % Light Distribution

Refractive IOLs and % Light Distribution
Pupil size 2 mm

Refractive IOLs and % Light Distribution
Pupil size 5 mm

% LIGHT DISTRIBUTION

<table>
<thead>
<tr>
<th>Pupil Size (mm)</th>
<th>Near</th>
<th>Intermediate</th>
<th>Far</th>
<th>Outside Range of Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mm</td>
<td>40%</td>
<td>0%</td>
<td>40%</td>
<td>20%</td>
</tr>
<tr>
<td>5 mm</td>
<td>10%</td>
<td>0%</td>
<td>84%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Disadvantages
- May need more time
- Near at large pupils
- No protection for intermediate vs.

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 (2004) with 0.5D Defocus and 5 mm Pupil Size

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

- Reduction of Contrast Sensitivity (up to 20%)
- Diffraction Groove (Blaze night) Creates Different Diffraction Efficiency and Light Loss
- Toric Multifocal when 0.75 D of Corneal Astigmatism
- Heats, Glare and Ghost Images are Difficult to Manage in Suspicious Patients
- Poor Intermediate Distance Vision
- 0.50 Dioptr 5E generates loss of one line of Visual Acuity
- Perfect Target: Plain Postop Refractive Results

Diffractive IOLs

- 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.
- In Multifocal cases, VA sensitivity to refractive error depends on a multifocal design.
- Repeated Multifocal Technology was close to monofocal for the width of the distance peak in defocused Curve measurements.
- Diffractive Multifocal Technology width of the Distance Peak was about half the monofocal width.
- The effect of refractive error was about twice more sensitive to than in case of a monofocal IOL.
Optivis™ MIOL (Laren Scientific, Inc.)

- Posterior multifocal surface consists of 3 zones.
- Zone 1 of Progressive Refractive powers for far and intermediate within central 1.5 mm diameter.
- Apodized Diffractive Zone 2 for far with 2.1 D effective add for near within 1.5 to 0.5 mm diameter.
- Peripheral Refractive Zone 3 is shaped for bi-sign asphericity.

Central Progressive power zone

- Zone 1 power profile starts with intermediate power at the center of the lens.
- Power profile shape is tear drop and range from fair to intermediate distance.
- Negative surface slope at Zone 1 and part of Base Surface of the diffractive Zone 2 is to expand depth of focus of far to intermediate.
- A refraction zone has advantages of utilizing 10% of sight for retinal image thus reducing overall light loss and compare with any other multifocal optic.

Optivis multifocal surface shape deviation from equivalent power sphere

- Lens body
- Zone 1 Zone 2 Zone 3
- Base Surface
- Apodization Zone 2
- Initial diffractive groove is to direct light to near focus.
- Zone 2 groove height reduce towards periphery in order to direct more light to far.
- Light Loss is smaller with more unequal far to near light split.
- Diffractive apodization aims to allocate the smallest surface area for equal far to near light split where light loss is the largest.

Optivis MIOL Asphericity

- Other Aspheric IOLs are designed to compensate for a selected level of corneal spherical aberration. This leads to a significant reduction of image contrast at large pupils with corrections different from conventional and lens decentration or tilt.
- Bi-sign asphericity is that at < 5 mm diameter it has eye aberration similar to spherical IOL for the extreme eyes. As the pupil increases, the aberration of opposite sign to the central area tends to balance out total eye aberration at large pupil.
- Bi-sign asphericity balances out aberration at large pupil within the lens itself for any corneal asphericity thus reducing reliance on specific corneal shape. The reduced improvement in image contrast at large pupils is maintained for different corneal asphericities and even with lens decentration or tilt.
LSA of Bi-Aspheric IOL

LSA graph can be divided into two regions:
- arrows towards positive direction to indicate positive spherical ray aberration for up to about 5 mm diameter, and
- arrows towards negative direction to indicate negative spherical ray aberration beyond 5 mm diameter.

Optivis™ MIOL (Aaren Scientific)

Advantages:
1. Intermediate focus in addition to Far and Near foci
2. Improved apodization to minimize light “lose”
3. Reduction in both, light “lose” and fraction of light to Near focus at large pupil – this is to reduce nighttime photophobia

% Light Distribution

<table>
<thead>
<tr>
<th>Near</th>
<th>Intermediate</th>
<th>Far</th>
<th>Outside Range of Vision</th>
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<tbody>
<tr>
<td>2 mm pupil</td>
<td>34%</td>
<td>18%</td>
<td>21%</td>
</tr>
<tr>
<td>3 mm pupil</td>
<td>47%</td>
<td>16%</td>
<td>33%</td>
</tr>
<tr>
<td>4 mm pupil</td>
<td>51%</td>
<td>9%</td>
<td>57%</td>
</tr>
<tr>
<td>5 mm pupil</td>
<td>50%</td>
<td>6%</td>
<td>73%</td>
</tr>
</tbody>
</table>

4. Bi-Asphericization to improve optical image contrast at large pupil for different corneal asphericities and even lens decentration and tilt.

Optivis™ MIOL (Aaren Scientific, Inc)

Materials and Methods

Optivas™ implanted in 82 eyes of 42 patients (40 bilateral implantation)
Mean age: 70.17 ± 6.25 years.
Follow-up: 3 years

- Uncorrected Distance (UCVA), Intermediate (UCVA), and Near (UCNA) Visual Acuity
- Best Corrected Distance (BCVA), Intermediate (BCVA), and Near (BCNA) Visual Acuity
The optical zone of the AT LISA® tri MIOL provides:
- a near addition of +3.31 D for a comfortable reading distance
- an intermediate addition of +1.61 D

It improves intermediate vision without compromising near or far vision.

AT LISA® tri MIOLs BCVA

<table>
<thead>
<tr>
<th>LO MAR</th>
<th>Preop</th>
<th>28 Week PO</th>
<th>1 Month PO</th>
<th>3 Months PO</th>
<th>6 Months PO</th>
<th>1 Year PO</th>
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<tr>
<td>Diopters</td>
<td>-0.29</td>
<td>-0.47</td>
<td>-0.13</td>
<td>0</td>
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<td>0</td>
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AT LISA® tri MIOLs Monocular Near Vision (ETDRS)

<table>
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<tr>
<th>20/20</th>
<th>50</th>
<th>80</th>
<th>90</th>
<th>100</th>
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<tr>
<td>1 Week PO</td>
<td>23.76</td>
<td>23.13</td>
<td>22.6</td>
<td>22</td>
</tr>
<tr>
<td>1 Month PO</td>
<td>25.07</td>
<td>24.50</td>
<td>23.5</td>
<td>23</td>
</tr>
<tr>
<td>3 Months PO</td>
<td>26.00</td>
<td>25.50</td>
<td>24.5</td>
<td>24</td>
</tr>
<tr>
<td>6 Months PO</td>
<td>27.00</td>
<td>26.50</td>
<td>25.5</td>
<td>25</td>
</tr>
<tr>
<td>1 Year PO</td>
<td>28.00</td>
<td>27.50</td>
<td>26.5</td>
<td>26</td>
</tr>
</tbody>
</table>

AT LISA® tri MIOLs Monocular Intermediate Vision (ETDRS)

AT LISA® tri MIOLs 1 Year Posi-op Result
Monocular defocus curve AT LISA® tri MIOL® ZEISS

ATLISA® tri No correction Far Vision

ATLISA® tri No correction Intermediate Vision

ATLISA® tri No correction Near Vision

AT LISA® Tri IOL contrast sensitivity
Daytime, Nighttime and Nighttime with glare

AcryLISA Toric® Study
Materials and Methods

AcryLISA® MIOL Implant in 35 eyes of 22 patients
Mean age: 61.80 ± 14.64 years.
Follow-up: 3 years

- Best corrected distance VA (BCVA) Distance
- Post-op Mean Refractive Astigmatism
- Post-op sphere equivalent
- Stroocelar Near VA
Pre-op Mean Corneal Astigmatism: 1.60 D
Pre-op Mean Refractive Astigmatism: 1.25 D
Mean ICL Astigmatism: 1.66 D

Post-op Mean Refractive Astigmatism:
(25 Eyes)
Pre-op Mean corneal astigmatism (1.63 D)

BCVA (35 Eyes)

Spheres Equivalent (35 Eyes)

% YAG LASER CAPSULOTOMY - 35 EYES

Early YAG Laser Treatments
(within one year postop)

7 Eyes: YAG laser treatments (21.2%)

Rotational stability and centration

Mandatory for a good long-term postoperative outcome after the implantation of a toric multifocal IOL is the rotational stability and centration of the lens.

Because of the AcrySof Acryliq design, ZEILO IOLs have proven excellent rotational stability and stable centration in more than 250,000 implantations.
Acri.LISA Study
Materials and Methods

Acri.LISA® MIOL implanted in 15 eyes of 3 patients
Mean age: 58.7 ± 12.09 years.
Follow-up: 3 years
- Best corrected distance VA (BCVA) Distance
- Post-op Mean Refractive Astigmatism
- Post-op Sphere Equivalent
- Binocular Near VA

Acri.LISA®
3 Years Post-op Result

Monocular defocus curve Acri.LISA®

Synchrophy Dual Optics AIOL

What is the Synchrophy AIOL?
- Single-piece, dual-optic silicone ICL
- Three dimensional lens designed to fill the capsular bag
- 5.5 mm high plus anterior optic (+22D)
- 6.0 mm variable negative posterior optic
- Optics connected by spring raptoes
- Size 9.5 mm x 9.8 mm

Synchrophy Dual Optics AIOL – 18 Months Clinical Results

> 31 eyes of 18 patients
> Mean Age: 71.52 ± 7.02
> Mean Preoperative BCVA: 0.67 ± 1.51
> Mean Time Follow Up: Days 550.86 ± 44.53
> Mean Preoperative Sphere Equivalent: 0.46 ± 1.43
> Incision Size: 3.75 mm using calibrated metal knife
**Synchrony Implantation Technique**

- Insert injector tip to CCC edge
- Release 1st optic
- Open capsular bag by pushing leading optic against the posterior capsule
- Deliver 2nd optic into capsular bag

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**Synchrony Dual Optics AIOL**

UCVA vs BCVA
50 Eyes

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**New Generation:**
**Synchrony VU Accommodating IOL**

- The new generation Synchrony® VU Accommodating IOL is designed to provide enhanced near vision without compromising quality of vision.
- Central blended aspheric zone designed to extend depth of focus.
- Latest innovation advancing the Synchrony platform.
- The lens is CE Mark approved

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**Synchrony Surgical Focal Points**

- No Contrast Sensitivity Penalization
- Halos or glare similar to Monofocal IOLs
- Future AMD: No future visual penalization due to IOl Technology
- Best choice for Susceptuous Patient, with Possible High Sensitivity to glare and halos, but highly demanding for New Technology IOLs
- Provide Intermediate Vision
Quality of Vision
Contrast Sensitivity and Control Values

Control values for CS are derived from Hohberger paper

- 10-14 healthy phakic subjects for the following age groups:
  * 0-20
  * 20-30
  * 30-40
  * 40-50
  * 50-60
  * 60-70
  * 70-80

- Functional Image Analyzer OPTEC 6500P
- Daytime (85 cd/m²), Nighttime (3 cd/m²) and Nighttime with Glare (3 cd/m²)
- Monocular testing
- Paper demonstrated strong age dependence of CS with age

Synchrony contrast sensitivity
Daytime, Nighttime and Nighttime with glare

Multifocal IOLs Contrast Sensitivity

Multifocal IOLs: AcrySof, AcrySof Toric, Tecnis, Ophtia

Cataract Surgery Main Complications - National Register
Where are we?

- 27% Posterior Capsule Opening
- 33% Endophthalmitis
- 26% Corneal Decompensation
- Only 61% of eyes see 20/20 after cataract surgery
- Biometry 91% within ± 1 D
Thank you for your attention!
“Multifocal IOL”

Eric D. Donnenfeld MD

**Multifocal IOL**
Eric D. Donnenfeld, M.D.
Optometric Consultants of Long Island

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**Case History**
- 59 year old healthy white female
- History increase IOP
- Mother has history of glaucoma
- Presents for refractive surgery
- Contact lens wearer (monovision)

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**Pre-op Exam**
- Pre-operative refraction
  - OD: -10.00 -1.25 x 90° 20/20
  - OS: -12.00 -1.00 x 87° 20/25-
- Central pachymetry
  - OD: 540 microns
  - OS: 530 microns
- Keratometry
  - OD: 42.02/43.12
  - OS: 42.23/42.87

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**History**
- Patient underwent sequential bilateral uneventful phacoemulsification with simultaneous “in-the-bag” implantation of a ReStor multifocal IOL.
- Patient c/o glare, halo and decreased visual acuity.
- Seeks second opinion.

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**Exam**
- Refraction
  - OD: Plano -1.25 x 170° 20/30-
  - OS: -0.25 -1.00 x 9° 20/50+
Recommendation

- Retinal Referral
- Topical NSAID qid
- Patient tried -3.00 glasses to mimic monofocal IOL
- Advise against IOL exchange but will be willing to consider as long as patient has full informed consent.
“Option for Secondary Posterior Chamber IOLs: Scleral Tunnel with Glue”

Roger F Steinert MD

Options for Secondary Posterior Chamber IOLs: Scleral Tunnel with Glue

Relevant Disclosures: None

Why This Technique?
- Late suture breakage of sutured PC IOLs
- Key breakthroughs to my acceptance of this technique:
  - See Amar Agarwal perform live surgery
  - Hear other surgeons *not* report late complications
  - Realize it is the tunnel, not the glue, that is responsible for long-term stability

WARNING: This is not easy!

However, the results have the potential of better long-term stability and therefore is worth the effort

My Preferred IOLs
- Staar AQ 2010V
- 13.5 mm haptic diameter
- 6.3 mm silicone optic
- Polymide (Supramid) haptic
  - Tough
  - No kinking of haptics!
- Aaren EC-3 PAL
- Acrylic optic; PolyVinylidene Fluoride haptics

Key Steps
- Carefully mark 180 degrees and dissect centered on those marks
Key Steps

- Carefully mark 100 degrees
- Use gentian violet to mark the tunnel when created with 21g needle

Key Steps

- Carefully mark 100 degrees
- Use gentian violet to mark the tunnel
- Insert AC maintainer
- MVR 21g puncture 1 mm posterior to limbus; use coaxial action micro-forceps
- Secure first haptic with Mackool hook retention “slider” or have a good surgical assistant!

Key Steps

- Carefully mark 100 degrees
- Use gentian violet to mark the tunnel
- Insert AC maintainer
- MVR 21g puncture 1 mm posterior to limbus; use coaxial action micro-forceps
- Secure first haptic with Mackool hook retention “slider” or have a good surgical assistant!
- Deliver second haptic with 2 instruments (Agarwal’s “handshake” maneuver)
Key Steps

- Carefully mark 180 degrees
- Use gentian violet to mark the tunnel
- Insert AC maintainer
- MVR 2.7g puncture 1 mm posterior to limbus; use coaxial action micro-forceps
- Secure first haptic with Mackool hook retention "slider" or have a good surgical assistant!!!
- Deliver second haptic with 2 instruments (Agarwall's "handshake" maneuver)
- Insert each haptic into tunnel

Key Steps

- Carefully mark 180 degrees
- Use gentian violet to mark the tunnel
- Insert AC maintainer
- MVR 2.7g puncture 1 mm posterior to limbus; use coaxial action micro-forceps
- Secure first haptic with Mackool hook retention "slider" or have a good surgical assistant!!!
- Deliver second haptic with 2 instruments (Agarwall's "handshake" maneuver)
- Insert each haptic into tunnel

Glue flap and conjunctiva

Summary

- Scleral tunnel fixation solves long-term suture degradation issue
- Tissue glue seals the sclerotomies and provides short-term stability
- The scleral compression of the haptic creates permanent stability
- Scleral tunnel fixation is worth the effort!
Thank You!!
"Preliminary Results of Intrastromal Femtosecond Astigmatism Keratotomy"

Steve Schallhorn MD

Preliminary Results of Intrastromal Femtosecond Astigmatic Keratotomy

Femtosecond Intra-stromal AK

- Advantages
  - The accuracy and precision of the femtosecond laser
  - No epithelial injury
  - Quick procedure
  - Fast visual recovery

- Disadvantages
  - Requires femtosecond laser/cost
  - Nomogram under development
  - Limit on maximum cylinder correction

Demographics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
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<tbody>
<tr>
<td>Patient (eyes)</td>
<td>105 pts (122 eyes)</td>
</tr>
<tr>
<td>Age</td>
<td>58 yrs range 21 to 78 yrs</td>
</tr>
<tr>
<td>Gender</td>
<td>58% male; 42% female</td>
</tr>
<tr>
<td>Eye treated</td>
<td>45% left; 54% right</td>
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Months from Primary Procedure

Preop and Postop Refraction

<table>
<thead>
<tr>
<th>Intended Cylinder Correction (D)</th>
<th>Arc length (degrees)</th>
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</thead>
<tbody>
<tr>
<td>-0.50 to -1.25</td>
<td>40</td>
</tr>
<tr>
<td>-1.50 to -1.75</td>
<td>50</td>
</tr>
<tr>
<td>-2.00 to -3.50</td>
<td>80 to 75</td>
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Preoperative

<table>
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<tr>
<th></th>
<th>1 month</th>
<th>3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphere</td>
<td>-0.01 to 0.19</td>
<td>-0.37 to 0.58</td>
</tr>
<tr>
<td>Cylinder</td>
<td>-1.27 to 0.60</td>
<td>-0.67 to 0.88</td>
</tr>
<tr>
<td>Axis</td>
<td>-0.05 to 0.43</td>
<td>-0.47 to 0.18</td>
</tr>
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</table>
Conclusions

- Initial results of intra-stromal femtosecond AK show that it can safely reduce moderate levels of astigmatism
  - Can be titrated but significant variability
- No change in MSE
- CR 0.78 indicates under-correction
- Appears stable
  - 1 week to 3 month followup
- Nomogram refinement underway
<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Minnesota Eye Consultants, PA Ste 200 9801 Dupont Ave S, Bloomington MN 55431-3200</td>
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<td></td>
<td><a href="mailto:ericdonnenfeld@gmail.com">ericdonnenfeld@gmail.com</a></td>
</tr>
<tr>
<td>STEPHEN S LANE MD</td>
<td>Medical Director, Associated Eye Care, Adjunct Clinical Professor, University of Minnesota</td>
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<td>01236 795 010</td>
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<td><a href="mailto:scschallhorn@yahoo.com">scschallhorn@yahoo.com</a></td>
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<tr>
<td>ROGER F STEINERT MD</td>
<td>Irving H. Leopold Professor and Chair Director, Gavin Herbert Eye Institute University of California, Irvine 118 Med Surge I, Irvine CA 92697-4375, Assistant: Adrienne Kols, <a href="mailto:akols@uci.edu">akols@uci.edu</a> ( +1) 949.824.8089</td>
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