Evolution of the Cataract Patient

Mark Maraman O.D., M.S.
Pacific Cataract and Laser Institute

Disclosures

I have no financial relationships or conflicts of interest with the manufacturers of any commercial products in this presentation.

The Past

- 1st recorded cataract extraction: French Ophthalmologist, Jacques Daniel on April 8, 1747
  - No anesthesia or asepsis and no microscope
  - 180 degree inferior corneal incision made to remove cataract
  - No sutures, patient laid for days/week with sandbags around head
  - ICCE: Intracapsular cataract extraction = entire lens and capsule removed
  - Cataract was removed by depressing the globe with his fingers
- But was this really the 1st cataract surgery?
900–400 BC
- 1st documented procedure called “couching”
- Performed by a Hindu surgeon named Sushruta
- Possibly as old as 1000 BC

Let’s Move Forward
- Moved from ECCE to ECCE: extracapsular cataract extraction—meaning the capsule was left in place. Early 1900’s Ignacio Barraquer
- Initially no artificial lens was placed in the eye, so

- 1st IOL material (1949) made out of PMMA and was done by British surgeon, Sir Harold Ridley
- Around this same time small caliber sutures now available
- Equipment and surgical technique advanced with smaller incisions: now around 2.5 mm in size

1st Phacoemulsification unit
- Filed for patent on July 25th, 1967
- Designed by Dr. Charles Kelman and Anton Banko
- 1st surgery took 76 minutes and 20,000 Hz
- Kelman’s backup plan was Ophthalmology, after failing as a musician
Advancement in IOLs

- More flexible materials developed
  - Silicone and Acrylate
  - Allowed for folding of the lens
  - Thereby allowing for smaller incisions and the beginning of sutureless surgery
- Additionally, the anterior capsulotomy evolved
  - From a can opener capsulotomy (1960’s): questionable stability of any lens in the bag
  - To Continuous Curvilinear Capsulorhexis (CCC) mid 1980’s: which allowed for IOL stability in the bag (PCOIL rather than sulcus or AIOIL)
  - Dr. Neuhann and Dr. Gimbel

The evolution of surgical instruments

Modern Day Cataract ASC
Surgical Challenges

Post Refractive Surgery

Lasik/PRK

RK

Post Refractive Surgery IOL Calculations

- IOL calculations are based on pristine corneas untouched by refractive surgery
  - Many (15—20) different calculation methods for prior LVC.
- Thus, previous Lasik/PRK makes calculations very challenging
  - What are the correct K measurements?
- Undesired refractive outcomes (refractive surprise) leading to the need for an IOL exchange is not uncommon and patient must be prepared for this possibility

Post Refractive K reading Calculations

- Historical Method
  - ASCRS calculator
  - OCT (Optovue) Net Corneal Power
  - Biometric K readings (lenstar, IOL, master)
- Topographically based
  - Anterior K power
    - Anterior plus posterior, or total K power (pentacam)
  - Total Corneal Refractive Power (TCRP)
  - Equivalent K Reading EKR 65 (average K reading over central cornea)
- A lot more
Previous RK

- RK patients will tend toward unusual refractive errors early p/o. Often hyperopic shifts–can be transient
- Increased astigmatism not unusual
- Patience is required by both patient and doctor

Post Refractive Surgery IOL Summary

- Are LVC patients more demanding?
- Use multiple methods for IOL calculations
- Set realistic expectations for patient

Additional tools

- Intraoperative aberrometry
- Femtosecond Laser
AperatureRx

Results
► Study of 246 eyes showed a 50% improvement in accuracy with use of the device in eyes with previous myopic LASIK compared against the surgeon’s best pre-op IOL choice.


Study

<table>
<thead>
<tr>
<th>Efficacy of IOL Power Prediction After Refractive Surgery</th>
<th>Non-Myopic Preop</th>
<th>Myopic Preop</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraocular lens surgeon</td>
<td>1.16 (0.634)</td>
<td>0.93 (0.297)</td>
<td>&gt;0.0500</td>
</tr>
<tr>
<td>Pentacam v1.30.2</td>
<td>87</td>
<td>&gt;0.0500</td>
<td></td>
</tr>
<tr>
<td>Pentacam v1.33.2</td>
<td>90</td>
<td>&gt;0.0500</td>
<td></td>
</tr>
</tbody>
</table>

(Continued on next page)
Advantage

- Increased accuracy for refractive cataract cases
- Reduces need for IOL exchanges

Disadvantages

- Cost to surgery center (ORA system is $3,000 per month)
- Cost to patient
- Intraoperative State is not physiologic
  - ACD varies during surgery
  - IOP variations
  - Wound hydration
  - Corneal edema
  - Viscoelastic
  - Effective lens position
Hill–RBF Formula

- Has been equaling or exceeding any other formula in most recent studies.
- As more post-op data is entered into the formula should see greater accuracy and even ability to isolate subsets of patients
  i.e. previous D/K or long/short eyes

Surgical Challenges

Unstable lens
Endocapsular Tension Ring

- Circumferentially distributes forces around the zonular apparatus
- Prevents further zonular dehiscence
- PXF, Trauma, rotated toric IOL?

How do we fix this?

- Transconjunctival Scleral Fixation
Surgical Challenges
Corneal Dystrophies

Fuchs' Epithelial Basement Membrane Dystrophy

- Risk is greater for p/o swelling
- Longer recovery and risk of decompensation
- Limited VA potential
- Viscoelastics used intraoperatively
- Pachymetry if corneal swelling suspected
- In severe cases:
  - Cataract surgery 1st
  - DMEK/DSEAK 1st
  - Combined

IOL Options

- Lens discussion with patient?
  - Yep you're getting one
- Patient expectations?
  - You'll see better
  - You'll need glasses
- Target options?
  - Near, distance, mono?

Location:
- ACIOL
- Sulcus IOL
- PCiol (1980s)
- Sutured

Types:
- Single focus
- Spherical

Materials:
- PMMA (1949) – realistically (1970s) hydrophobic
- Hydrogels (1950s) – foldable but unstable, hydrophilic
- Silicone (1978) – primary IOL of the 1980s
- Acrylic – hydrophobic and hydrophilic

- Location:
  - ACIOl
  - Sulcus IOL
  - POIOl

- Materials:
  - PMMA
  - Silicone
  - Acrylic—Predominantly hydrophobic


- Features:
  - Aspherical = reduced spherical aberration
  - Square posterior optic edge = reduced PCO

- Types:
  - Single focus
  - Toric: Staar Toric (1998), AcrySof restor, Tecnis, Trulign
  - Accommodating: Crystalens, Trulign Toric accommodating IOL
  - Multifocal: Array (1997), ReZoom (Alcon), Restor (Alcon), Restor Toric, Tecnis MFL
  - Extended range of focus (ERFs): Symfony (Abbott)

Toric IOLs

- AcrySof
- Tecnis
- Trulign
- Staar
Toric IOLs

- Correct from 1.00 to 4.25 of Cylinder
- Approximately 37.7% of the patient population has greater than 1D of astigmatism
- Alcon Restor, AMO Tecnis Toric, Starr Toric, Crystalens Trualign

Accommodating IOLs

- Crystalens and Trulign (Toric)
- Anterior movement of IOL upon ciliary muscle contraction
- Does it work?
- Pseudoaccommodation vs true phakic accommodation (probably both)
- Variability in outcomes—available in one diameter
- Monovision
- Good distance and intermediate vision
- Halo—same as monofocal IOL
- Plate haptics make exchange difficult
- Several versions: Crystalens, AO, HD, 5.0, AD
- Earlier models: Z pattern formation
- Capsular contraction and need for Yag relaxing incisions
- When it works, it works great
MF-IOLS

- Available in three add powers
  - +2.5 (+2.0 at spec)
  - +3.0 (+2.5 at spec)
  - +4.0 (+3.2 at spec)
- "Natural" tint
- Apodized diffractive rings on front surface

Alcon RESTOR

- Available in three add powers
  - +2.5 (+2.0 at spec)
  - +3.0 (+2.5 at spec)
  - +4.0 (+3.2 at spec)
- "Natural" tint
- Apodized diffractive rings on front surface

AcrySof IQ ReStor Multifocal Toric IOL

- Table of specifications
  - Specification: [details]
AMO Tecnis MFL
- Available in three add powers
  - +4.0, +3.25, and +2.75
- Glare/Halos increase with add power
- Diffractive surface on posterior of lens
- Spherical Only

Extended Depth of Focus (EDOF) IOLs

AMO Tecnis Symfony
- Echelette design to provide an extended depth of focus.
  - Taller and angled
- Achromatic design to increase contrast sensitivity.
- Available as a toric IOL correcting up to 3.00 D at the corneal plane.
- 85% of patients wore specs none or a little bit of the time in the FDA study.
What’s so important about Chromatic Aberration?

All lenses have some degree of chromatic aberration.
Proprietary Achromatic Technology is designed to minimize the chromatic aberration of the lens.

Compared Lenses with Achromatic Technology

Defocus Curve

AMO Tecnis Symfony

- Coming soon higher add power EDOF
IOL’s: The Future

- Light Adjustable Lenses
- Accommodating
- Extended depth of focus (EDOF—IOLs)
- Electro-optical
- Refractive?

RxSIGHT (formerly Calhoun Vision)
Light Adjustable Lens (RxLAL)

- 1st post surgical adjustable IOL
- FDA approved Nov. 22nd, 2017
- Projected U.S. launch 2nd quarter 2019

Calhoun Light Adjustable IOL
Standard IOL results

- Virgin Cornea with axial length 22–26
  - MRSE $\leq 1.00$ D $= > 90$
  - MRSE $\leq 0.50$ D $= > 70–80$
- Prior LVC
  - MRSE $\leq 1.00$ D $= > 70–80$
  - MRSE $\leq 0.50$ D $= > 40–67$

RxLAL Results

- Germany: 122 eyes
  - 98% $\leq 0.50$D of target
  - 100% $\geq 20/25$ UCVA
  - 88% $\geq 20/20$ UCVA
- US Study: 391 eyes
  - 90% $\leq 0.50$ D of target
  - 92% $\geq 20/25$ UCVA
  - 70% $\geq 20/20$ UCVA

Previous LVC IOL outcomes


- 34 eyes
  - MRSE
    - +/- 0.25 – 741
    - +/- 0.50 – 470
    - +/- 1.00 – 400
RxLAL Multifocality?

- Using UV irradiating light beam with varying spatial intensity can create steepened periphery and flattened center creating smoother "multifocal" effect compared to traditional MFL IOL = less glare/halos.

DynaCurve by Nulens

Akkolens Lumina Accommodating IOL
IOLs (outside of U.S.)

- Lentis Mplus multifocal IOL (Oculentis GmbH, Berlin, Germany)
- Tetraflex Presbyopic IOL (Lenstec, St. Petersburg, Florida)
- Synchrony (AMO)
  Pulled from FDA consideration by AMO in 2014

Things I've learned about recommending and counseling patients prior to cataract surgery
Why it’s all worth it

Questions?