Overview of Cataract Surgery:
1. Newest Technology
2. A Refractive Procedure

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Financial Disclosures: Consultant for these Companies
- Alcon
- Allergan
- AMO
- Bausch and Lomb

Our Strive Towards Perfection
- Our goal is to meet our patients' expectations
- Expectations of our patients are constantly rising
- Technological improvements and advances
- Media/Press/Internet
- Demands of our society
“Baby Boomers”
- Generation with high expectations
- High levels of activity
- Do not accept limitations with vision (Presbyopia)
- Do not want to get older
- The “bar” has been raised

Patient Expectations Regarding Cataract Surgery:
- Excellent vision
- Immediate results
- Pain free
- Without side effects

Surgical Goals:
- Proper patient selection
- Education of patients - expectations and limitation of surgery, options
- Identify and treat underlying conditions that may limit our surgical results
- Meticulous surgery
Symptoms Associated with Cataracts

- Blurred vision
- Double vision
- Glare and haloes around lights
- Difficulty with reading or making out signs
- Increased sensitivity to the sun or lights
- Dimness
- Blunting of colors

Cataract Surgery

- Medical Indications:
  - after trauma damage to the lens
  - dense cataract limits view of posterior pole pathology (macular degeneration, diabetic retinopathy etc.)

Cataract Surgery

- The most commonly performed surgery in the United States
- Market Scope – 3 million cases in 2007 and 2008
- The goal of the surgery – replace the "cloudy" natural lens with an intraocular lens implant
Cataract Surgery
- Many changes/transformations
- Procedure of last resort – limited vision and extended recovery
- Procedure of choice - to immediate restoration of excellent vision
- Spectacle independence
- Restore near vision

Transformation of Cataract Surgery
- 1. Surgical Techniques
- 2. Intra Ocular Implants
- 3. Surgical Equipment and Devices

Intra Capsular Cataract Surgery
- Removal of entire cataract and capsular bag structure
- Very large incision
- Limited activity
- Visual limitations – “coke bottle” glasses
Extracapsular Cataract Surgery

- Most commonly performed in 1980-1990's
- Large incision
- Cataract removed manually
- Sutures required
- Limited activity – bending, protection of eye
- Prolonged healing – 6-8 weeks
- Needed to remove the sutures

Phacoemulsification

- Ultrasonic power "breaks down" the cataract
- Very small incision is made – no sutures
- Quicker healing
- Vision restored within days
- No restrictions in activities immediately

Laser Assisted Cataract Surgery
Lens Implants
- Microscopic
- Foldable
- Incision needed is about 3 mm
- Quick healing
- Immediate restoration of vision

Surgical Equipment and Devices
- Viscoelastic Devices
- IOL folders, inserters
- Phacoemulsification machines/technology
- Dyes
- Iris Expanders

The Surgical Procedure
Cataract Surgery
- Ambulatory surgery
- Hospitals or Surgery Centers
- Different procedures depending on the surgeon
- Surgical time is very short

Surgical Video
What About the Difficult Case?

Technological Advances with Instrumentation and Materials can Convert a “Difficult Case” into a Routine One!

Poor Dilation

- Can lead to difficulty
- Increased complications
- Associated syndromes or conditions that increase risk of complications
  - IFIS – Floppy Iris Syndrome
  - Flomax (tamsulosin) – alpha-1 adrenergic receptor antagonist
  - Pseudoexfoliation
  - Associated with prior ocular inflammation
Poor Dilation

○ Pharmacologic:
  • NSAIDS pre operative
  • Topical phenylephrine 10%
  • Intracameral epinephrine – Diluted forms of Epinephrine PF (1:1000)

○ Viscoelastics: Viscoat, Healon 5

○ Mechanical Devices to Physically open and maintain the pupil opening
  • Stretch – Kuglen, collarbuttons, Beehler pupil dilator etc.
  • Iris hooks
  • Morcher ring, Malyugin ring, etc.
Malyugin Ring

Poor Red Reflex

Required in order to allow visualization of the phacoemulsification

- Head positioning
- OPMI Lumera microscope – (Zeiss) Xenon light
- Dyes – Trypan Blue
Refractive Results with Cataract Surgery

- Cataract Surgery a form of Refractive Surgery
- Excellent results with monofocal intraocular lens implants. Acrylic, Silicone or PMMA.
  - Monofocal setting – distance mostly, near in myopes
  - Monovision

Lens Implants

- They provide the power to focus
- Different power lenses correct vision to achieve different goals
- In past goal was to correct for distance, require reading glasses
- New generation of lenses- Presbyopic correcting lenses provide full range of vision
- Astigmatism correcting lenses

Presbyopic Correcting Lenses

- Intraocular lens implants designed to give the patient “full range” of vision in a post operative setting
- Multiple designs by different companies
- Goal is to minimize the dependence on spectacles or contact lenses after cataract or clear lens surgery
Presbyopic Correcting Intraocular Lens Implants

- Restore - Alcon
- Rezoom - AMO
- Tecnis – AMO
- Crystalens – B&L

The IOL Portfolio

IOL’s come in many sizes, shapes & materials. Each has unique characteristics & capabilities

Single Power Lenses
- Corrects only distance vision
- Does not accommodate in eye
- Glasses required

Multifocal/Defractive Lenses
- Multiple, fixed focal points
- Does not accommodate
- Must find appropriate focal point
- Extensive neurological adaptation

Accommodating Lens
- Single focal point
- Full range of distance, intermediate & near vision
- Uses eye’s natural focusing mechanism
- Rapid visual recovery

Anatomy of the Apodized Diffractive IOL

Step heights decrease peripherally from 1.3 to 0.2 microns

A +4.0 add at lens plane equaling +3.2 at spectacle plane

Central 3.6 mm diffractive structure
AcrySof® IQ ReSTOR® IOL

SN6AD3
Add Power: +4.0 D
Spectacle Plane: +1.2 D
Range: +10.0 D to +34.0 D
A-Constant: 118.9

SN6AD1
Add Power: +3.0 D
Spectacle Plane: +2.5 D
Range: +10.0 D to +34.0 D
A-Constant: 118.9

Overall Frequency of Spectacle Wear (Bilateral comparison)

How often do you wear eyeglasses?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Never Sometimes Always

IQ ReSTOR® IOL +3.0 D [N=138]
IQ ReSTOR® IOL +4.0 D [N=131]

Balanced View Optics™ Technology

Pictorial representation
ReZoom™ IOL Spectacle Independence

Source: Product labeling.

The vast majority of subjects reported being able to function comfortably without glasses at all distances.

N=112

- Note: Residual Astigmatism not corrected
Multifocal Lenses

- Multiple focal points viewed at one time
- Adaptation required – may take weeks to months, improves after second eye surgery
- May require glasses for intermediate or near functions
- Night complaints due to multifocal images with larger pupils

Crystalens

Eyeonics/B&L

Crystalens

- Accommodating intraocular lens
  - There is only one focal length but it shifts
  - Increased depth of focus due to its posterior positioning
- There is a learning curve, the patient needs to learn how to accommodate with this lens in place
Ciliary Muscle

MRI

Future Intraocular Lens Implants

Lenstec Tetraflex
- Acrylic
- Pseudo accommodation (increase in high order abberations)
- US studies (12 sites) - average amount of accommodation 1.8 diopters

Images courtesy of Susan A. Strenk
Light Adjusted Lens – Calhoun Vision

- Photosensitive silicone- uv light can increase or decrease the power
- Can correct astigmatism
- Wait 2 weeks after lens implantation or adjustment
- Need to be shielded from uv light
- Final treatment “locks in” the treatment

Light Adjusted Lens

- US trials- 85% of patients ultimately within 0.5 diopters of plano
- International studies- 95% within 0.5 diopters
- May offer a solution to post refractive IOL miscalculations

Synchrony Lens (AMO, Visiogen)

- Uses 2 optics to increase vision range. Connected by a spring apparatus
- Silicone lenses
- No haloes and glare
- Best for intermediate vision (computer)
Other Lenses
- Rayner M-Flex T - multifocal toric
- DnaCurve (Nulens Ltd)
- AcriLisa (Carl Zeiss)
- Adoptics (Hoya)

Patient Selection
Pre-operative Exclusion Criteria
- Subjective Exclusion
  - Hypercritical patients
  - Patients with unrealistic expectations
  - Occupational - night drivers, pilots
  - Unmotivated patients

Pre Operative Evaluations:
- Meticulous Biometry measurements required
- IOL Master
- Immersion Ultrasonography
- Topographic analysis/ multiple keratometry readings
- Multiple IOL formulas
### Patient Discussions:

- Expectations
- Alternatives
- Financial Implications
- Side Effects
- Bilateral Need for surgery
- Neuro Adaptation – may take months

### Premium Lenses

- Patients can not tolerate residual refractive errors (spherical or astigmatic) - Multifocal lenses
- Poor quality of vision – haloes, glare, vague complaints, etc.
- Must be able to perform enhancements
  - LRI/AK – astigmatism
  - Laser vision correction
  - IOL exchange or piggyback lens

### Astigmatism

- Focusing ability of the eye is different at different axes
- Effected by the cornea and natural lens
- Once the natural lens is removed – cornea is the only factor
- Cataract surgery is essentially neutral in it's astigmatism effect
So What About Astigmatism?

How do we treat it?

Surgical Correction of Astigmatism - Procedures Available

- Limbal Relaxing Incisions – procedure of choice
- Astigmatic Keratotomy
- Laser Vision Correction – if assoc. with spherical error
- Intraocular Lens Implants

Surgical Incisions to Correct Astigmatism

- Cataract Surgery – Astigmatism is based only on the curvature of the cornea
  - Easy to perform – patient is anesthetized, in operative setting
  - Takes short length of time
  - Topical setting
  - Need to know where the astigmatism is
  - Treatment results depend on length, depth and number of incisions made
Limbal Relaxing Incisions

- Useful in correcting up to 2 diopters of astigmatism
- Require a diamond blade – 600 micron depth
- Lack of side effects
- Can be performed before or after the cataract is removed

Corneal Topography

Astigmatism
Limbal Relaxing Incisions

Intraocular Lens for the Correction of Astigmatism
- Alcon and Staar
- Toric Intra Ocular Lens Implants
- Predictable
- Standard Cataract Surgery + Alignment of the Lens in the axis of the astigmatism

AcrySo® IQ Toric IOL Specifications
AcrySof® IQ Toric IOL Calculator

Makes precise surgical planning easy!

**Intuitive input**
- Patient data
- Keratometry
- IOL spherical power
- Surgically induced astigmatism
- Incision location

**Powerful output**
- Recommended IOL model and spherical equivalent power
- Optimal axis placement
- Magnitude and axis of anticipated residual astigmatism
Tecnis One Piece Toric
- Acrylic
- Treats up to 3.00 diopters
- European studies

Acrysof IQ Restor Multifocal Toric Lens
- Diffractive IOL
- Aspheric
- Blue filter
- ASCRS 2011 - Khonen, T (Germany) - 98 cases up to 3 diopters. Results similar to Restore Multifocal
- US trial 2012

Wave Tech - Orange
- Intra aberrrometry – aphakic state
  - “Invaluable” in post lasik IOL calculations
- technique to measure amount and direction of astigmatism
- LRI – length and locations of astigmatism
- Toric IOL - alignment
Conclusion: Cataract Surgery

- Medical and Technological advances – extremely successful procedure
- Improve the quality of a patient’s life
- Restoring vision as well as minimizing or eliminating the need for spectacle correction

Femtosecond – Assisted Cataract Surgery

Gerard D’Aversa, MD
Partner, Ophthalmic Consultants of Long Island
Femtosecond – Assisted Cataract Surgery

- Exciting New Technology
- Does It Improve the Results of Cataract Surgery
- Is it Safe and Reliable
- Can the Market Support its Cost/Expense
- Is it for Everyone?

Surgical Systems

LenSx®

LensAR™
Surgical Systems

Catalys™

Technolas™

Cataract Surgery- Patient Expectations:

- Excellent Vision
- Rapid visual recovery
- Safety and comfort

Cataract Surgery

- Increased volume of cataract surgery due to population increase
- Age of patients is decreasing
- “Baby boomer” population – do not want to alter their active lifestyle
- Increased interest in Presbyopic Correcting Lenses
- Increased interest in the “best” technology available
- Want the best results possible
Femtosecond Assisted Laser Cataract Surgery - Goal

- Goal: to achieve levels of uncorrected visual acuities similar to Lasik
  - Precise, reproducible corneal incisions
  - Well centered and well designed capsulorrhexis that will optimize the IOL position
  - More precise management of pre op astigmatism
  - Decrease complications associated with cataract surgery

Video
FEMTOSECOND ASSISTED CATARACT SURGERY
Capsulorrhexis - size and shape

- Effective IOL position can lead to refractive errors
- Controlling the size, centration and shape
- If capsular contraction is more uniform, the ELP is less variable
- Greater accuracy with laser than manual

Effects of Capsulorrhexis Contracture

Effects of Capsular Contracture
Femtosecond Laser Capsulorrhexis

LASER CAPSULOTOMY - METHODS

- Non-Randomized, Single Site, Single Surgeon Study (Robert Cionni, MD, The Eye Institute of Utah)
- Three Lens Types (Alcon SN60WF, Restor, and Toric)
- Manual Group (n=51)
  - Attempted 5.0mm Capsulotomy (Mastel 5.75 mm OZ marker to create 5.0 mm CCC)
- LenSx Laser Group (n=48)
  - Femtosecond Laser Created 5.0 mm Capsulotomy
- Accuracy to Target, Actual ELP (Lenstar – ACD), Visual Acuity
  - 1 Month Postop

STUDY RESULTS – ACCURACY TO TARGET

<table>
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<th>Lens Type</th>
<th>Within 0.25D</th>
<th>Within 0.50D</th>
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<td>LenSx</td>
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- All 3 IOLs: 0.00D 0.25D 0.50D 0.75D 1.00D
Prospective, Non-Randomized, Multi-Site Study
Single Lens Type (Acrysof Platform- SN60WF)
83 Eyes (Laser Capsulotomy = 39 Manual Capsulotomy = 44)
Kerry Solomon, M.D., Robert Cionni, M.D.
1 Month Postop: Accuracy to Target & Visual Acuity

Absolute Value of Spherical Equivalent Prediction Error (D)

- LenSx (n=39)
- Manual (n=44)

20/20 or Better 20/25 or Better 20/40 or Better 20/50 or Worse
AAO 2011– Femtosecond Scientific Papers

- Juan Battle – compared diameter, circularity and centration of laser assisted capsulorrhexis vs manual.
  - Laser capsulorrhexis diameter compared to intended were on avg 29 +/- 26 um vs. 339 +/- 248 um for manual
  - Centration for femto was within 77 um of intended results

Astigmatism Correction

- Estimated >70% of patients have astigmatism of 0.5 Diopters or more
- Uncorrected astigmatism leads to decreased Va
- Significant factor in patient results with multifocal IOL implantation
- FSAK precise length, depth, location and orientation of each incision
- Can enhance post operative

LASER ARCUATE INCISION

- Fully Customizable and adjustable
  - Adjustable during the procedure or postoperatively at slit lamp
  - Refractive incisions are no longer an art form. They are a science.
  - Place Desired Incisions:
    - EXACT Size
    - EXACT Place
    - EXACT Depth
    - Every Time
Refractive Results:
A more precise relaxing incision

LRIs with Femtosecond lasers:
• Potentially more consistent and predictable astigmatic management compared to manual LRIs\(^1,2\)

\(\text{1. Slade S. Donnenfeld Femtosecond Lasers in Refractive cataract Surgery. AAO, October 2010.}

\)

**LASER ARCUATE INCISIONS METHODS**

**Single Site Case Series**
Dr. Eric Donnenfeld
First 14 Cases with the Laser

(7 OD, 7 OS)
Preop Cylinder (0.80 ± 0.0053, 0.50, 2.50)

9mm Arc Incisions
85% Depth

**RESULTS - LASER ARCUATE INCISIONS**

Pre OP (n=14)
- Keratometric Centroid: +0.08D @ 17° ± 0.59D, \(\rho = 1.82\)

Post OP (n=14)
- Refractive Centroid: +0.26D @ 178° ± 0.23D, \(\rho = 0.45\)

1 Month Post Op:
- 71% within 0.25DC
- 86% within 0.50DC
- 100% within 1.00 DC
LASER ARCUATE INCISIONS METHODS

Multi-Site
- Dr. Stephen Slade – 19 cases
- Dr. Richard Mackool – 6 cases
- Dr. Eric Donnenfeld – 16 cases
- Enrolled 39 eyes (21 OD, 19 OS)

Depth
- 90% (Mackool)
- 85% (Donnenfeld)
- 80% (Slade)

Diameter – 9mm (3), 10mm (2), 10.6mm(2), 11mm (2)

Various Laser Settings and Nomograms Used

Preoperative Cylinder:
- (1.01 ± 0.65, 0.00, 2.50)

Femtosecond Laser Incisions

- Incision length, depth, direction, width all are programmed preoperatively and verified in "real-time"
- Precise and reproducible

Improved Cataract Incision

Improved cataract incisions lead to the following:
- A tighter self-sealing seal
- More consistent incision
- Unique incision architecture
Femtosecond Assisted Laser Cataract Surgery – Decreased Complications associated with Cataract Surgery

- Decrease the risk of vitreous loss by decreasing complications in the making of the capsulorrhexis
- Improved surgical wound closure
- Decrease damage to the corneal endothelium from less phaco time and inflammation

Femtosecond Laser Fragmentation of the Nucleus

Liquify
- Used for softer lenses (Grade 2)
- Number of cylinders customizable

Chop
- Generally used for harder lenses (Grade 3, 4+)
- Number of cuts customizable

Now Available: Hybrid Pattern
- Combination of Liquefaction and Chop Patterns
- Efficient for all cataract grades
- Rapid lens removal with minimal phaco required
- Preferred pattern for surgeons going forward

LASER FRAGMENTATION PATTERNS
Reduced phaco energy data by cataract density

![Graph showing reduced phaco energy data by cataract density.](image)

Source: Culbertson, Royal Hawaiian Eye Meeting Presentation, January 2011

RESULTS - LASER FRAGMENTATION

The reduction in ultrasound energy used during Laser Refractive Cataract Surgery may result in less inflammatory response and preservation of endothelial cells. *CCT was significantly lower (p<.05) compared

![Graph showing CCT comparison between conventional and laser-assisted groups.](image)

AAO – Femtosecond Scientific Papers

- Mark Packer – endothelial cell density at 3 and 6 months after cataract surgery
  - 3 months no difference
  - 6 months: mean cell loss was 1.5% in laser assisted group vs. 4.8% cell loss in conventional phaco group
Highly Reproducible Capsulotomy

- 100% of LenSx Laser procedures achieved an accuracy within 0.25 mm
- Only 10% of manual procedures
- No radial tears

Real Advantages of Femtosecond Laser Assisted Cataract Surgery

- To be able to perform precise and reproducible surgery
  - More accurate and well centered capsulorrhexis
  - More accurate astigmatic corrections
- Decrease complications associated with capsulorrhexis creation
- Decrease phaco power and time – preservation of the corneal endothelium

Differences in the laser systems:

- Lensx and Technolas – applanation lens directly in contact with cornea
- Optimedica and Lensar – fluid filled "docking" apparatus
- Imaging of the anterior segment varies (OCT, Scheimpflug images)
Changes in the OR with the Laser Assisted Cataract Technology

- Location of the laser
- Topical procedure
- Ability to placing the docking device on the globe (fissure size)
- Air bubbles in the anterior chamber
- Pupillary constriction
- Giving a peri-bulbar block with the incisions being created

Thoughts to Consider:

- There is not enough data at this point to know exactly what all the benefits of this technology are
- Femtosecond laser technology is very likely going to get better (newer generation machines and software)
- Our surgical techniques may change due to the use of the laser
- Costs likely will decrease

Conclusion

- Exciting times
- As technology progresses, surgical results will improve
- Use the technology either in it’s entirety or “a la carte”
- Patient satisfaction will increase
- Surgeon satisfaction will increase
Thank you