Cataract Surgery optimizing outcomes

Cornea update

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Cataract Surgery - Goal

- "Pushed" from a purely medical procedure to one of refractive surgery
- Optimize outcomes – Post-op refraction within +/- 0.5D sphere and cylinder
- Reduce risk – “dropless cataract surgery”

Prevalence of Astigmatism

![Astigmatism Chart]

0% 5% 10% 15% 20% 25% 30% 35%
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
30% 31% 19% 10% 6% 5% 1% 1% 0% 0% 0%
CORNEAL CYLINDER (D)

0.5 D to 5.0 D = 70%

Astigmatism: Surgical Options

- Astigmatic Keratometry: Diamond knife or Femto
- Clear Cornea Incision on steep axis (single or paired)
- Limbal relaxing incision
- Scleral Recession

Astigmatism correction: varies with clear corneal incision placement:

Paired Clear Corneal incision on steep axis 1.0 cylinder
Astigmatic Keratotomy: Clear Cornea incision single vs paired

Astigmatism: Limbal Relaxing Incisions (LRI’s) < 1.5D cylinder

Astigmatism: Femtosecond – intrastromal

Femtosecond – 7mm OZ - Intrastromal

Scleral recession (modified scleral tunnel) for with the rule astigmatism 1.0D or greater

Figure 3: Three-month intended refraction change versus surgically induced refractive change.

Scleral recession. Astigmatism steep at 90°. After Scleral Astigmatism Neutralized.
Pre-op vs post-op residual astigmatism
(n=24 eyes) 2mos-3 yrs f/u

Attempted Astigmatism correction (D)

LASIK or PRK (lamellar) with Cataract Surgery

Indications:
- pre-op: astigmatism > 1.5 diopters
- post-op: undesirable ametropia

Flap creation:
- preferably make it pre-op
- post-op: wait three months

CustomVue treatment:
- wait at least one month post cataract/ICL surgery

Hitting your target with toric IOL’s

- >= 1 Diopter
- AMO/Alcon 1-4d cylinder magnitude

Cylinder Powers
AMO Toric and Alcon AcrySof Toric SN6AT
Spherical Powers: 6.0 – 30.0 D

<table>
<thead>
<tr>
<th>Model</th>
<th>Cylinder Power @ IOL Plane</th>
<th>Cylinder Power @ Corneal Plane*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZCT150</td>
<td>1.5</td>
<td>1.03</td>
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<tr>
<td>ZCT225</td>
<td>2.25</td>
<td>1.55</td>
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<td>ZCT300</td>
<td>3.0</td>
<td>2.06</td>
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<tr>
<td>ZCT400</td>
<td>4.0</td>
<td>2.74</td>
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TORIC IOL’s

AMO

Wavefront guided LASIK
Wavelight (Alcon) vs Custom Vue (VISX)

Figure 1 Predictability was excellent for both technologies.
**Cylinder Powers**
AMO Toric and Alcon AcrySof Toric SN6AT

**Spherical Powers:** 6.0 – 30.0 D

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<tr>
<td>ZCT450</td>
<td>4.5</td>
<td>3.08</td>
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<td>ZCT525</td>
<td>5.25</td>
<td>3.6</td>
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<tr>
<td>ZCT600</td>
<td>6.0</td>
<td>4.11</td>
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</tbody>
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**Accommodating IOL:**
Trulign Toric – Crystalens Cylinder: 0.83-1.83D

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**Trulign Toric**
addresses TWO unmet clinical needs of cataract patients in one procedure:

(i) reducing the visual impact of residual uncorrected astigmatism

(ii) uncorrected distance, intermediate vision and functional near vision.

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**Mean Distance-corrected vision at various vergences**
EXCELLENT DISTANCE AND INTERMEDIATE, GOOD NEAR

Uncorrected visual acuity at all distances

**Symfony Toric – 97% satisfaction**

- Extended depth of focus
- 1-2.6 D cylinder (cornea plane)

**Multifocal IOL’s**

- AMO  2.0, 2.37, 3.0 D Adds
- ALCON  2.0, 2.5 D Adds
- ALCON Toric option available April 2017

- Target: must be near plano, no cylinder.

Intraoperative Keratometer

How do we select “correct” power IOL?
**IOL Formulas 1977: Refraction based**

- add +19.0D to pre-cataract refraction

**IOL Formulas 1979: Refraction based**

- Emmetropic: 21.0D
- Myopic: 15D
- Hyperopic: 25D
- Large lens power errors commonplace

**IOL Formulas 1980’s: Regression Formulas**

- Empiric formulas generated by retrospective analysis and averaging data from large number of patients after cataract surgery
- Improved refractive prediction
- Lens power errors were commonplace:

**IOL Formulas: Keratometry and Ultrasound Biometry (solid probe and immersion)**

**1980’s: Theoretical Formulas**

- SRK T, Holladay 1, Hoffer-Q
- Axial Length and K’s
- All require an estimation of the effective lens (IOL) position
- Refractive errors still occur
- Within +/- 1.00D of target sphere
IOL Formulas (Optical Biometry)
2013 “Benchmark Standard”
• +/- 0.5D 70%
• +/- 1.00D 90%

IOL Formulas (Optical Biometry)
2017: Theoretical Formulas
• Holliday 2, Haigis, Barret Universal II, Olsen
• Axial Length, K’s, Lens thickness, W-W, AC depth,
• All require an estimation of the effective lens (IOL) position
• Refractive errors still occur

Measuring Points:
32 (lenstar) vs 6 (IOL Master 500/700)

Barret Toric Calculator:
calculates estimated net corneal astigmatism
(Anterior/Posterior Cornea)
1. Posterior corneal surface is a minus lens: if steep vertically, creates power @ 180 deg
2. Estimates amount of posterior corneal astigmatism
Hill-RBF Calculator

- Selects IOL power using artificial intelligence-driven pattern recognition
- Does not depend on effective lens position

Enhancement options: INFORM IN ADVANCE OF CATARACT SURGERY!

- Glasses/Contact lenses
- IOL Exchange
- Astigmatic Keratotomy – Limbal Relaxing incision
- Laser Vision Correction
- "mini" RK (one/two incisions)

Cornea 2017

- What’s New?

Astigmatism

Irregular vs Regular

100 yrs: So what’s wrong with Penetrating Keratoplasty (PK)?
20 y/o PK 7.5mm – keratoconus suture in 1 yr after surgery

Cornea Donor Study
Ophthalmology 2008 - Cornea Donor Study Investigator Group

PK’s don’t always last a lifetime...

PK’s – Scourges
Cornea Graft Rejection

Case report (ASCRS listserv)
- 17 yo severe keratoconus, atopic dermatitis
- PK x 3
- Graft rejection/failure each time
- Immune suppression: cytoxan?
- Regraft?
- Keratoprosthesis?

Deep Anterior Lamellar Keratoplasty (DALK)  Challenge:
Severe Keratoconus with scar
hx of cornea hydrops – age 19

Intraoperative Keratometer
DALK/PK – before suture adjustment

Intraoperative Keratometer
DALK/PK – after suture adjustment: improves early optical rehabilitation

Severe Keratoconus with scar
20 yo 15 mos aft DALK suture out
- 5.0 + 0.5 x 20 20/20

31 yo severe keratoconus/scar

VERY Early visual rehabilitation
Large Diameter DALK (10mm dia)
-9.0 20/30 8 days post-op
37 yo male Severe Reis Bucklers Cornea Dystrophy

USA  DALK vs PK  2011-2015

Are we conserving recipient endothelial cells during surgery and what is long term graft survival?

Fuchs’ Corneal Dystrophy - 39% Transplants

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DSEK: it’s so good, why change? It’s all about vision quality!
- 80% BSCVA 20/40
- Only 30% achieve 20/20
Fuchs’ Corneal Dystrophy - 39% Transplants

DMEK:
Visual outcome @ 6mos (n = 221)
BSCVA:
- ≥20/40 98%
- ≥20/25 79%
- ≥20/20 46%
- ≥20/18 14%
Negligible refractive shift

Contact Lens & Anterior Eye - Melles
Volume 36, Issue 1, Pages 13-21, February 2013

Graft Rejection after 2 yrs:
DMEK (400 eyes) vs DSEK vs PK
- DMEK 20x less than PK.
- DMEK 15x less than DSEK


Graft Rejection
DMEK >2400 eyes 3-4yrs aft surgery
- DMEK <1%

Price et al. DMEK Risk of Immunologic Rejection
Ophthalmology 2016

5-year endothelial cell density: our DSEK and DMEK vs. CDS PK

Price et al. Ophthalmology 2013;120:246-51
Feng, Price et al. JCRS 2014;40:1116-21

Growth of DMEK in the United States

84% increase since 2012; now 17% of EK procedures up from 11% in 2014
DMEK Procedures performed in the United States

Price et al. Ophthalmology 2013;120:246-51
Feng, Price et al. JCRS 2014;40:1116-21
Cornea Transplantation USA 2015
Total Corneas 79,304
- 48,792 (vs 35,300 in 1995)
- 30,512 exported internationally
- 3.8 million cataract procedures

Cornea Transplantation - World 2012
742 Eye Banks reporting
- 184,576 transplants
- Performed in 116 countries
- Corneas procured in 82 countries
- 53% of world’s population have NO ACCESS to cornea transplantation!
- 12.7 million waiting for cornea transplantation

One Donor = Two Recipients!!
Review of the First 100 Consecutive Patients
- Reduce cornea donor tissue shortage!
- Reduce cost

Cornea Regenerative Medicine
- Cultivation of Human Cornea Endothelial Cell Cultures
- Transfer to the anterior chamber of the eye
- Restore endothelial cell counts