Management of Astigmatism in Cataract Surgery

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  - Consultant
- Bausch and Lomb
  - Consultant

Introduction

The goal of modern cataract surgery is to achieve emmetropia or balance with the fellow eye.

1. Control the spherical component
   - IOL Master or LensStar
   - Water bath ultrasound
   - Keratometry or topography

2. Manage the astigmatic component
   - Size and location of the cataract wound
   - Peripheral Corneal Relaying Incisions (PCRI)
   - Toric IOLs
   - Postoperative management
     - Astigmatic Keratotomy; Wound Revision or Excimer laser
Introduction

- Goal is to achieve ≤ 0.50 D of post-op cylinder to minimize the need for post-operative spectacles

What is the best way to manage astigmatism?

- PCRI
- Toric IOLs

Peripheral Corneal Relaxing Incisions (PCRI)

- Incisions made ~ 90% depth, in front of the limbus, in the steep meridian of the cornea
- Incisions in the peripheral clear cornea
  - Heals faster
  - Refractive effect stabilizes quickly
  - Less irregular astigmatism, glare, and foreign body sensation
Pre-operative Assessment of Astigmatism
Magnitude and Axis

- Manual Keratometry
- IOL master or LENSTAR
- Corneal Topography
- Elevation mapping

Pre-op Assessment of Astigmatism

- Best test for axis
  - IOL master – quantitative
  - Topography – qualitative
- Best test for power
  - Manual Keratometry
  - IOL master

Intra-operative - Alignment

- Alignment is critical!

Traditional Method
- Mark the 6 o’clock or 3, 6, and 9 o’clock positions on the patient’s limbus with the patient sitting up looking straight ahead with both eyes open.
Intra-operative - Alignment

- In the OR, mark the steep corneal axis, using a marked fixation ring, astigmatic ruler or arcuate marker with the 90º mark aligned with the 6 o'clock mark on the cornea.

Many different types of astigmatic markers are available.

Mark in mm or in degrees depending upon which nomogram used.
III. Peripheral Corneal Relaxing Incisions -

**Technique**

- Measure the thinnest limbal corneal thickness and set the diamond knife or use a preset diamond knife set to 600 microns.
- Make incisions before cataract surgery using a single footplate front cutting diamond blade.

**Nomograms**

- Can correct 1.00 – 3.00D of astigmatism.
- Base technique on one of many established nomograms:
  - a. Gills/Fenzel
  - b. Nichamin
  - c. Koch

[LRIcalculator.com from AMO]
III. Peripheral Corneal Relaxing Incisions - Example

Example:
- A 75yo pt. With 2.5 D @ 180º:
  - Use paired 45º cuts (Koch) at the limbus at the 3 o'clock position or paired 50º cuts (Nichamin) at 180º.

Peripheral Corneal Relaxing Incisions - Technique -

- Make incisions at the beginning of the case
- While the corneal epithelium is still pristine
- While the eye is still closed and IOP is controlled
III. Peripheral Corneal Relaxing Incisions

- After PCRI is made, make your usual temporal cataract incision
- If the PCRI is against-the-rule:
  - Limit the PCRI to 3 mm length and make cataract incision within the PCRI
- If the PCRI is with-the-rule:
  - Make paracentesis peripherally and PCRI more centrally
  - Calculate the IOL in the same way as normal - no change in spherical equivalent is produced
Femto-second LRIs

Femto LRI Video

Complications

- Under correction
- Over correction - including flipped axis
- Perforation – examine peripheral cornea pre-op to look for peripheral thinning
- Wound leak
  - Relaxing incision made coincident with extrastar wound at 180°
  - Secondary to tear of the PCRI
- Interference with paracentesis
  - PCRI made at 90 degrees
Peripheral Corneal Relaxing Incisions
Special Indications

- High corneal astigmatism
  - > 5.00 D
  - Combine PCRI with Toric IOLs

- Low corneal astigmatism
  - 0.75 – 1.25 D

- Irregular corneal astigmatism
  - Non-orthogonal axis
  - When exact axis is question
  - Inability to implant a planned Toric IOL secondary to capsular break or annular instability, still can correct cylinder with a PCRI

Toric Lenses

STAAR

Alcon

Rayner Toric IOLs

C-flex IOL (570C)
Superflex® IOL (620H)
Sulfacryl® Toric (655T)
II. Staar Toric IOL

A. A plate-haptic style foldable silicone IOL

B. A biconvex 6mm optic IOL with a spherocylinder anterior surface and a spherical posterior surface

C. The interhaptic diameter is 10.8 mm with a 1.15 mm round hole

D. Powers of 2.0 D and 3.5 D that can correct from 1.5 - 3.5 D of preoperative astigmatism

II. Staar Toric IOL

Complications:
- Decentration of IOL - ?? increased in plate IOL’s?
- Lens rotation or shift
  - Lose 3.3% of cylinder with each degree off axis
  - May need manipulation of IOL, at slit lamp or in the OR
- Increased posterior capsule opacification??
- Increased pitting of silicone with YAG??
- Bad IOL for Pt’s at risk for vitrectomy
TECNIS Toric Aspheric IOL

- On line toric calculator
- www.tecnistoriccalc.com
Trulign Toric Accommodating Intraocular Lens

Based upon the Crystalens AO platform

• Astigmatic powers
  - 1.25, 2.00, 2.75 D
  - 0.83, 1.33, 1.83 D at the corneal plane

• Spherical power
  - 17.0 – 25.0 D

Trulign online IOL calculator

AcrySof® TORIC IOL

Design
- AcrySof Single-Piece platform
- Aspheric
- Posterior toricity
- Spherical Power +6 to +30 D
- Astigmatic power 1 – 5 D

Dimensions
- Overall length: 13.0 mm
- Optic diameter: 6.0 mm
- A-Constant = 119.0 for SN6AT

Delivery
- Monarch III Injector
- B, C or D Cartridge

Steep K alignment marks
Cylinder Powers

A wide range of cylinder powers means more candidates can benefit from AcrySof® IQ Toric IOL.

### ALCON® LENS MODELS

<table>
<thead>
<tr>
<th>SN6AT3</th>
<th>SN6AT4</th>
<th>SN6AT5</th>
<th>SN6AT6</th>
<th>SN6AT7</th>
<th>SN6AT8</th>
<th>SN6AT9</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOL Plane</td>
<td>3.50 D</td>
<td>2.00 D</td>
<td>1.50 D</td>
<td>1.00 D</td>
<td>0.50 D</td>
<td>0.00 D</td>
</tr>
<tr>
<td>Corneal Plane</td>
<td>1.50 D</td>
<td>2.00 D</td>
<td>2.50 D</td>
<td>3.00 D</td>
<td>3.50 D</td>
<td>4.00 D</td>
</tr>
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### Recommended Corneal Astigmatism Correction Range

<table>
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<tr>
<th>Range</th>
<th>Cylinder Power</th>
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<tr>
<td>0.75 D to 1.54 D</td>
<td>1.55 D to 2.05 D</td>
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*Based on average pseudophakic human eye.

Rotational Stability – Important!

IOL rotation can have significant impact on astigmatism correction.

- Generally, for every 1° of IOL rotation, 3.3% of lens cylinder power is lost.
- A complete loss of cylinder power can occur with a rotation of >30°.
Toric IOL Procedural Considerations

- Surgeon performs standard cataract procedure from capsulorhexis through phacoemulsification
- Toric IOL implantation requires only minor variation from standard procedure:
  1. IOL calculation
  2. Marking of the eye
  3. IOL alignment (on-axis)

1. IOL Calculation

Step I:
- Determine required spherical power using preferred method

Step II:
- Utilize AcrySof Toric IOL Calculator to determine:
  - The correct Toric model
  - Optimal axis location of the IOL
  - www.acrysoftoriccalculator.com

AcrySof® IOL Calculator
Home Page
AcrySof Toric IOL Calculator

Precision Calculations:
- Uses vector analysis to determine correct axis
- Compensates for surgically induced astigmatism

Data Input:
- Preoperative manual keratometry
- Eye power
- Incision location
- Estimated surgically induced astigmatism

2. Marking of the Eye

I. Reference Marks (pre-op)
- Single mark at 6:00 limbus
- Patient in sitting position (avoid cyclotorsion)

II. Axis Marks (intra-op)
- Axis marks identify the optimal axis of IOL placement
- Axis marks are placed on the eye using 6 o’clock pre-op reference mark for alignment steep axis
3. IOL Alignment

3 Step Procedure:
I. Gross alignment
II. Removal of OVD
III. Final alignment

I. Gross Alignment
- Rotate IOL clockwise to approximately 5 - 10 degrees short of desired position or on axis if can be kept stable
- Complete while the IOL is unfolding in the capsular bag
IOL Alignment

II. Stabilize IOL During OVD Removal
- Take care to prevent IOL from rotating past intended axis during OVD removal
  - 2nd instrument
  - I/A tip - polyester
  - Bi-manual I/A
- Thoroughly remove all the OVD from behind IOL

III. Final Alignment
- Carefully rotate IOL clockwise precisely onto the intended axis of alignment with infusion running
- Tap IOL down into capsular bag to seat lens in place
Patient Selection

- 1 to 5 diopters of cylinder
- Intact capsule
- Continuous curvilinear capsulotomy (CCC)
- In the bag lens placement

Alcon Toric
Alcon Toric

New Technology
Refining the Astigmatism axis location
- TrueVision 3D system
- Clarity-Holos
- Verion

New Technology
Intra-operative aberometry
WaveTec
ORA
LASIK has produced high expectations:
- 92.6% of LASIK patients with vision of 20/40 or better*
- 95.4% of patients satisfied with their outcome after LASIK surgery**
- ~93% of LASIK patients within ±0.5 D

Cataract surgery outcomes are not meeting this post-op standard of ±0.5 D

Outcomes Not Meeting Expectations...

Sources of Post-op Error

*Estimated Best  
LASIK Outcomes
Possible Fix
The VERION
Image Guided System

Designed to add greater astigmatic accuracy during surgical planning and execution.

VERION™ Reference Unit
VERION™ Digital Marker

VERION Reference Unit

Image:
- Captures a high-resolution reference image of the patient’s eye
- Auto-detects scleral vessels, limbus, pupil, and iris features
- Measures keratometry, pupillometry

Plan:
Enables surgeons to determine an optimized surgical plan:
- Multiple IOL formula calculations, yielding lens power selection
- Incision and implantation axis planning
Comprehensive Astigmatism Planner

Image and Plan Video

VERION Digital Marker

Guide
- Displays patient information and images from the VERION Reference Unit
- A tracking overlay enables surgeons to see all incisions and alignment in real time
- Tracking accounts for cyclorotation
- Eliminates the need for manual eye markings
- Assists in accurate centering and alignment of multifocal and toric IOLs
The VERION Digital Marker can be used with the LenSx Laser as well as most surgical microscopes.

**With LenSx Laser:**

**With OR Microscope:**

LenSx Laser Dock

VERION Digital Marker
Registration at the Scope (after LenSx Laser)
New Developments
Intra-operative aberometry

WaveTec
ORA

The ORA System

Provides on demand information which assists in intraoperative decision making

Utilizes Talbot Moiré interferometry

Enables real-time surgical course correction

Attaches directly to existing surgical microscopes

ORA System Components

AnalyzOR™ Web Based Data System
Allows for entry of pre and post-op information into the database from any computer via the web, thereby post-op results facilitate optimizing ORA IOL power calculations

Aberrometer
ORA provides both Aphakic & Pseudophakic refraction for:

- IOL power calculation
- Axis of astigmatism
- Magnitude of astigmatism

Surgical Cart
The monitor displays:

- 3 camera view of the eye during the measurement process
- On-demand refractive information
VerifEye is the new monitoring hardware upgrade that provides continuous refractive information.

- Streaming refractive information
- Verifies that the eye is stable and ready for measurement
- IOL power recommendations
- Astigmatic guidance
- Shorter measurement time
  - Faster processor
    - 2 seconds for measurement
    - 3 seconds for processing

Requirements for Successful Measurement

- Widely Opened Eye
- Well Hydrated Eye
- Well Pressurized Eye
- Well Aligned Eye
In Summary

- Need to know how and when to use both Toric IOLs and PCRs.
- PCRs - remain a necessary part of your surgical armamentarium.