**Toric IOLs: Minimizing & Managing Residual Astigmatism**

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**Ideal Toric IOL Calcs**

- Accurate corneal power and astigmatism … repeat is SD > 0.020 D (0.030 mm)
- Exact Toric Calculator (not a constant ratio of corneal astigmatism to toricity (1.46))
- Proper Surgically Induced Astigmatism (SIA) for incision location and magnitude and axis of PreOp astigmatism … must account for ATR over 3 to 6 months PostOp
- Results will be greater than 80% within 0.50 D

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**Corneal Power Decision Tree**

No drops Blink, Blink, …

Keratometry SD > 0.20 D

Dry Eye? Yes

Ref Sx, KC, PMD, …? No

20% of cases

H2, Olsen, Barrett Formula (7 variables)

No Toric? Yes

Exact Toric Calc w Back Surface

ToMography 4.5 mm Zonal K

No SD > 0.03 mm Yes

Treat > 6 wks

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**Financial Disclosure**

- I have the following financial interests or relationships to disclose:
  - Abbott Medical Optics: C;
  - AcuFocus, Inc.: C,O;
  - Alcon Laboratories, Inc.: C;
  - ArcScan: C,O;
  - Carl Zeiss Inc: C;
  - Elenza: C,O;
  - Oculus, Inc.: C;
  - Visiometrics: C,O;

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If SD for K’s > ± 0.20 D (> ± 0.030 mm)
Test for Dry Eye
ToPography/ToMography

If SD > ± 0.20 D (> ± 0.030 mm)
Not Dry Eye
ToPography/ToMography

Never Perfect Bow Tie

TORIC IOL Calculations
- Commercial Calculators use a constant ratio (1.46) for the corneal cylinder to the IOL cylinder
- Exact Calculation depends on IOL SEQ Power and ELP … to correct 2D of corneal astigmatism
  - 10 D IOL => 3.5 D Cylinder
  - 22 D IOL => 2.9 D Cylinder
  - 34 D IOL => 2.4 D Cylinder
- A 1.1 D difference from 10 D to 34 D!
**Toric Calculators**

**Exact**
- Holladay On-line
- AMO Express On-line
- Holladay IOL Consult

**Approximate**
- Alcon On-line
- B & L On-line
- Barrett On-line

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**Dioptric Error vs. Angular Error for a 1.00 D of astigmatism**

<table>
<thead>
<tr>
<th>Angle Error (°)</th>
<th>Dioptric Error (D)</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>0.00</td>
<td>0%</td>
</tr>
<tr>
<td>15°</td>
<td>0.52</td>
<td>52%</td>
</tr>
<tr>
<td>30°</td>
<td>1.00</td>
<td>100%</td>
</tr>
<tr>
<td>45°</td>
<td>1.41</td>
<td>141%</td>
</tr>
<tr>
<td>60°</td>
<td>1.73</td>
<td>173%</td>
</tr>
<tr>
<td>75°</td>
<td>1.93</td>
<td>193%</td>
</tr>
<tr>
<td>90°</td>
<td>2.00</td>
<td>200%</td>
</tr>
</tbody>
</table>

Dioptric Error = 2 * Cyl * sin (angular error)

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**Surgically Induced Astig (SIA)**

- Critical to use correct value
- Not ~0.35 D WTR for small (2.5 mm), near-clear temporal incision
- Better to use Zero SIA and Baylor Nomogram
  - ↓ WTR (steep 90) by ONE Toric Size (T4 → T3)
  - ↑ ATR (steep 180) by ONE Toric Size (T3 → T4)
  - No change in Oblique
- Equivalent to ADDING ~ 0.51 D ATR as SIA
Wang/Koch Recommendation

- WTR: Subtract 0.6 D from measured
- ATR: Add 0.2 D to measured
- Oblique: No change

Equivalent to:

\[ SIA = 0.2 + 0.4 \sin^2(\text{Steep axis of astigmatism}) \]

<table>
<thead>
<tr>
<th>Steep Axis (°)</th>
<th>Magnitude (D)</th>
<th>Axis of Flattening (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.20</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>0.21</td>
<td>90</td>
</tr>
<tr>
<td>20</td>
<td>0.25</td>
<td>90</td>
</tr>
<tr>
<td>30</td>
<td>0.30</td>
<td>90</td>
</tr>
<tr>
<td>40</td>
<td>0.37</td>
<td>90</td>
</tr>
<tr>
<td>45</td>
<td>0.40</td>
<td>90</td>
</tr>
<tr>
<td>50</td>
<td>0.43</td>
<td>90</td>
</tr>
<tr>
<td>60</td>
<td>0.50</td>
<td>90</td>
</tr>
<tr>
<td>70</td>
<td>0.55</td>
<td>90</td>
</tr>
<tr>
<td>80</td>
<td>0.59</td>
<td>90</td>
</tr>
</tbody>
</table>

Additional Factors (Wang/Koch)

- Posterior cornea has ~ 0.25 D WTR
- WTR decays ~ 0.50 D WTR
- ATR decays ~ 0.00 D ATR

Result:

- \( K \) \text{WTR by } 0.75 \text{ D}
- \( K \) \text{ATR by } 0.25 \text{ D}
Post Op Toric Calculators

- Holladay IOL Consultant
  - www.hicsoap.com
- Berdahl & Hardten Toric IOL Calculator
  - www.astigmatismfix.com

Two Sources of Error

- IOL misaligned (wrong axis)
- IOL Toricity wrong (over/under)

Or

- Both

**Measuring Current Axis**
Improving Toric IOL Calculations

**Post Op Back Calc**

**PREOP 6 D Toric IOL**

**PREOP 6 D Toric IOL -- OD**

**PREOP 6 D Toric IOL -- OS**
Toric Calc Example 2

Manual:
42.00 @ 170 & 42.87 @ 85

LenStar:
41.34 @ 128 & 42.80 @ 38

1. 40°
2. 146°
3. Visually:
Steep @ 40 and Flat @ 0
So optimal @ 20
Exchange Toric Case #2 Lessons

- Irregular Astigmatism – outcomes unpredictable
- Post Op: measure the orientation of the IOL at slit lamp (reticule)
- Run Exact Post Op Back Calc with CURRENT AXIS for ideal axis and resulting refraction

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!Thank You!