Biometry in the post refractive surgery patient

The Frontiers of Cataract Surgery
Royal Society of Medicine
8th October 2015

Ali A. Mearza FRCOphth
Consultant Ophthalmic Surgeon
Imperial College Healthcare NHS Trust
Background

• A significant number of patients coming for cataract / RLE surgery will have had previous laser refractive surgery

• With increasing use of “premium lenses”, accuracy of IOL calculation is critical

• Patient expectations are forever on the increase
Outline

• Why miscalculations occur
• Methods to improve accuracy of IOL calculations
• Clinical Approach
• Options when faced with a refractive surprise
Variables in IOL Power Formulas

- Corneal Power (Average K)
- Axial Length
- Effective Lens Position (Calculation of AC Depth)
- White to White Diameter (WTW)
- Lens thickness
Corneal Power is main problem

• Most manual keratometers / topography systems use a corneal index of refraction of 1.3375

• Assumption that the posterior radius of curvature is 1.2 mm less than the anterior ROC

• Assumption that the anterior and posterior ROC’s are parallel

• Corneal power is used in the prediction of effective lens position (ELP), which is the depth of the IOL relative to the cornea
Figure 1. Laser vision correction alters the anterior corneal curvature but not the posterior curvature. This alters the normal anterior/posterior corneal curvature ratio.
Why is the corneal power inaccurate?

Calculation of Total Corneal Power:

\[
\text{Power (D)} = \frac{(n^c - n^a)}{r}
\]

\(n^c\) = index of refraction of the cornea (Typically 1.3375)

\(n^a\) = index of refraction of air (normally 1)

\(r\) = anterior radius of curvature of the cornea
Why is the corneal power inaccurate?

Calculation of Total Corneal Power:

Power (D) = \( \frac{(n^c - n^a)}{r} \)

\( n^c \) = index of refraction of the cornea (Typically 1.3375)
\( n^a \) = index of refraction of air (normally 1)
\( r \) = anterior radius of curvature of the cornea
After LASIK / PRK

- Change in anterior radius of curvature
- No change in posterior ROC
- Therefore, there is inaccurate calculation of the corneal power from a correctly measured anterior radius of curvature
- Myopic treatments reduce the power of the cornea- results in under-estimation of lens power
- Hyperopic treatments results in over-estimation of lens power
Measured Corneal Power

• Over-estimation of the true corneal power
  Seitz B et al. Underestimation of intraocular lens power for cataract surgery after myopic PRK. Ophthalmology 1999; 106:693-702

• Manual Keratometry over-estimates by 36%

• Topography over-estimates by up to 56%

• Corneal power over-estimation worse the higher the laser correction e.g. correction of –5.00 leads to a 1 Dioptre over-correction of corneal power
Methods to calculate true corneal power

• Different formulas used based on the data available i.e. if we have pre-op K’s and refraction or not
Clinical History Method
(Holladay, Hoffer)

Pre KR Mean K = 44.00 D

Change in SEQ Ref = -4.50 D

Calc Mean K = 39.50 D
Subtraction of 24% SEQ Change (Holladay)

e.g. SEQ change is -5D

24% of 5D = 1.2

New \( K = \) **Post-op Measured \( K \) – 1.2** (24% SEQ Change)
Other Methods

• Double K Method-
  Aramberri et al J Cat Refract Surg 2003;29:2063-2068

• Regression Formula-

• Latkany Method, Feiz & Mannis Method, Corneal bypass method
Appendix

Double-K SRK7T Formula

Equation 1: Preoperative corneal radius of curvature:

\[ r_{pre} = 337.5 / \text{Kpre} \]

Equation 2: Corrected axial length (LCOR):

\[
\begin{align*}
\text{If } L & \leq 24.2, \text{ LCOR} = L \\
\text{If } L > 24.2, \text{ LCOR} & = -3.446 + 1.716 \\
& \times L - 0.0237 \times L^2
\end{align*}
\]

Equation 3: Computed corneal width (Cw):

\[ C_w = -5.41 + 0.58412 \times \text{LCOR} + 0.098 \times \text{Kpre} \]

Equation 4: Corneal height (H):

\[ H = r_{pre} - \sqrt{r_{pre}^2 - (C_w/4)} \]

Equation 5: Offset value:

\[ \text{Offset} = \text{ACD}_{\text{post}} - 3.336 \]

Equation 6: Estimated postoperative ELP (ACD):

\[ \text{ACD}_{\text{est}} = H + \text{Offset} \]

Equation 7: Constants:

\[ \nu = 12; n_a = 1.336; n_d = 1.333; n_m = 0.333 \]

Equation 8: Retinal thickness (RETHICK) and optical axial length (LOPT):

\[ \text{RETHICK} = 0.65696 - 0.02029 \times L \]

\[ \text{LOPT} = L + \text{RETHICK} \]

Equation 9: Postoperative corneal radius of curvature:

\[ r_{post} = 337.5 / \text{Kpost} \]

Equation 10: Emmetropia IOL power (IOL_{emn}):

\[
\begin{align*}
\text{IOL}_{\text{emn}} = & \left( 1000 \times n_a \times (n \times r_{post} - n_m) \times \text{LOPT} \right) / \left( (\text{LOPT} - \text{ACD}_{\text{est}}) \times (n \times r_{post} - n_m \times \text{ACD}_{\text{est}}) \right)
\end{align*}
\]

Variables

- L = axial length
- Kpre = pre refractive surgery K-value
- Kpost = post refractive surgery K-value
- ACD_{post} = IOL constant (can be computed from A-constant).
Corneal bypass method

- IOL power is calculated using the post-LASIK axial length and the pre-LASIK keratometry
- Target refraction is set for the pre-LASIK spherical equivalent
- Bypasses the post LASIK corneal power
Pre-op Biometry (pre-LASIK)

Pre-op manifest SEQ = -4.00  (Av. K=44.5, AL=26)

Pre-op Biometry:

<table>
<thead>
<tr>
<th>Power (D)</th>
<th>Target Ref.</th>
<th>Power (D)</th>
<th>Target Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.5</td>
<td>0.68</td>
<td>16.5</td>
<td>-3.41</td>
</tr>
<tr>
<td>11.0</td>
<td>0.36</td>
<td>17.0</td>
<td>-3.78</td>
</tr>
<tr>
<td>11.5</td>
<td>0.03</td>
<td>17.5</td>
<td>-4.15</td>
</tr>
<tr>
<td>12.0</td>
<td>-0.29</td>
<td>18.00</td>
<td>-4.53</td>
</tr>
<tr>
<td>12.5</td>
<td>-0.62</td>
<td>18.53</td>
<td>-4.91</td>
</tr>
</tbody>
</table>
No pre-op data?

- Hard Contact Lens Method
Hard Contact Lens Method

Plano HCL Base Curve = 41.00 D
SEQ Ref without CL = +0.50 D
SEQ Ref with CL = -1.00 D

Mean $K = 41.00 - 1.50 \ (\text{Change in Refraction})$

= 39.50 D
Haigis L

- \( r_{corr} = 331.5/-5.1625 \times r_{meas} + 82.2603 - 0.35 \)
- \( D_{corr} = 337.5 / r_{corr} \)

- Built in software of the IOL Master
- Regression formula based on statistics
- Accuracy decreases on the edges of normal distribution
Other Formulas

• Modified Maloney Method


(information derived from the pentacam)
Bestt Formula MEH

- Bestt Formula, Smith et al, JCRS 2006
- Requires Pentacam’s measurements
  - Ant and Posterior Radii of curvature
  - Central corneal thickness
  - Axial length
- No need for pre-refractive surgery info
- 46 % eyes within 0.5 and 100 % within 1 diopters

5.0 mm total axial power & 4mm total optical power from the Orbscan II (Don’t rely on the index of refraction 1.3375) Statistically better than the History method in their 21 eyes
Measures central cornea and the anterior and posterior corneal surface very precisely which is the key for the “Holladay Report”.

Available as an upgrade for the Pentacam
Consensus “K” method

- Randleman et al JCRS 2007;33:1892
- Use several K prediction methods
- Exclude High/Low outliers
- Average the rest
- Showed much better prediction than using individual methods
Intra-operative biometry

- Introduced in 2005
- Lanchulev et al JCRS 2005
- ALCON
- Wavetec
- ORA
- Problems with view / accuracy but improving with every software upgrade
Ray Tracing

• Lots of excitement
• Results as good as the Haigis L, Hoffer Q (double K) and Olsen 2 (double K)
• Lots of work going into this
• Promising technology as does not rely on Gaussian Optics i.e. no assumptions!
• Does not rely on IOL formula
Light Adjustable lens

• Could be a place for this technology
• Can only correct +/- 1.00 D at present
Clinical Approach-Counselling

• Realistic Expectations

• Target Refraction (consider doing non-dominant eye first)

• Topography (beware irregular topography)

• IOL Choice
What do I do?
IOL power calculation in eyes that have undergone LASIK/PRK/RK

Warren Hill, M.D.
Li Wang, M.D., Ph.D.
Douglas D. Koch, M.D.

Version 4.6
Made possible by an unrestricted educational grant from Alcon Laboratories and The ASCRS Foundation

Disclaimer

The IOL Calculator is meant to serve as an adjunct tool to assist physicians in selecting the appropriate IOL for a particular patient. It is intended to be used in conjunction with a comprehensive ophthalmic examination and the appropriate diagnostic tests and measurements necessary for cataract surgery candidates with a history of prior refractive surgery. The results obtained by the calculator are not intended to serve as medical or surgical instruction from the ASCRS, or be definitive; nor can ASCRS guarantee that the results will be accurate in every case. Physicians who use the calculator must arrive at their own independent determinations regarding the proper treatment for their patients and are solely responsible for the refractive outcome. By using the IOL Calculator, you agree to waive and hold ASCRS and authors harmless from any claims you may have arising out of your use of this tool.
IOL power calculation in eyes that have undergone LASIK/PRK/RK

Warren Hill, M.D.
Li Wang, M.D., Ph.D.
Douglas D. Koch, M.D.

Version 4.6
Made possible by an unrestricted educational grant from Alcon Laboratories and The ASCRS Foundation

Updates

2015 Updates:
1. We have added the Barrett True K formula for myopic LASIK/PRK eyes, hyperopic LASIK/PRK eyes, and RK eyes.
2. We have added the OCT-based IOL power calculation formula (RTVue, Optovue) for myopic LASIK/PRK eyes, hyperopic LASIK/PRK eyes, and RK eyes.
3. For myopic LASIK/PRK eyes, we have added the Potvin-Hill Pentacam method using the Pentacam value.
4. Because of the reduced accuracy of the formulas that entirely depend on historical data, we have removed methods in the column "Using Pre-LASIK/PRK Ks + ?MR".

I accept.
Please enter all data available and press "Calculate"

<table>
<thead>
<tr>
<th>Doctor Name</th>
<th>Patient Name</th>
<th>previous patient-MK</th>
<th>Eye</th>
<th>IOL Model</th>
<th>Hayner</th>
<th>Target Ref (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.25</td>
</tr>
</tbody>
</table>

**Pre-LASIK/PRK Data:**
- **Refraction**
  - Sph(D): 1.79
  - Cyl(D)*: -1.00
- **Keratometry**
  - K1(D): 41.7
  - K2(D): 40.2
- **Vertex (if empty, 12.5 mm will be used)**: 12

**Post-LASIK/PRK Data:**
- **Refraction**§
  - Sph(D): 1.50
  - Cyl(D)*: -1.00
  - Vertex(mm): 12

**Topography**
- **EvoSys**
- **EffRP**
- **Atlas 9000**
- **Tomey ACP**
- **Nidek ACP/APP**
- **Galilei TCP**
  - V5.2.1 or later
  - V5.2 or earlier

<table>
<thead>
<tr>
<th>Topography</th>
<th>Net Corneal Power</th>
<th>Posterior Corneal Power</th>
<th>Central Corneal Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Atlas Ring Values**
- 0mm
- 1mm
- 2mm
- 3mm

**OCT (RTVue or Avanti XR)**
- **Net Corneal Power**
- **Posterior Corneal Power**
- **Central Corneal Thickness**

**Optical (IOLMaster/Lenstar)/Ultrasound Biometric Data:**
- **Ks**
  - K1(D): 43.86
  - K2(D): 45.18

<table>
<thead>
<tr>
<th>Ks</th>
<th>AL(mm)</th>
<th>ACD(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1(D)</td>
<td>22.03</td>
<td>2.76</td>
</tr>
<tr>
<td>K2(D)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lens Constants****

<table>
<thead>
<tr>
<th>Lens Constants</th>
<th>A-const(SRK/T)</th>
<th>SF(Holladay1)</th>
<th>Haigis a0</th>
<th>Haigis a1</th>
<th>Haigis a2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>118.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If entering "Sph(D)", you must enter a value for "Cyl(D)", even if it is zero.
§Most recent stable refraction prior to development of a cataract.
# Magellan ACP or OPD-Scan III APP 3-mm manual value (personal communication Stephen D. Klyce, PhD).
**Select the version of your Galilei device: "V5.2 or earlier" or "V5.2.1 or later".
***Select the keratometric index (n) of your device. Instruments in North America typically default to 1.3375.
****Enter any constants available; others will be calculated from those entered. If ultrasound AL is entered, be sure to use your ultrasound lens constants.
Optical (IOLMaster/Lenstar)/Ultrasound Biometric Data:

<table>
<thead>
<tr>
<th>Ks</th>
<th>K1(D)</th>
<th>K2(D)</th>
<th>Keratometric Index (n)**</th>
<th>Lens Thick (mm)</th>
<th>WTW (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>43.86</td>
<td>45.18</td>
<td>1.3375 1.332 Other</td>
<td>4.60</td>
<td>12.79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AL(mm)</th>
<th>ACD(mm)</th>
<th>Lens Constants****</th>
<th>SF(Holladay1)</th>
<th>Haigis a0</th>
<th>Haigis a1</th>
<th>Haigis a2</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.63</td>
<td>2.70</td>
<td>A-const(SRK/T)</td>
<td>118.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If entering "Sph(D)", you must enter a value for "Cyl(D)", even if it is zero.

**Most recent stable refraction prior to development of a cataract.

***Magellan ACP or OPD-Scan III APP 3-mm manual value (personal communication Stephen D. Klyce, PhD).

**Select the version of your Galilei device: "V5.2 or earlier" or "V5.2.1 or later".

****Enter any constants available; others will be calculated from those entered. If ultrasonic AL is entered, be sure to use your ultrasound lens constants.

Please check Pre-LASIK/PRK refraction.

IOL calculation formulas used: Double-K Holladay 1\(^1\), Shammas-PL\(^2\), Haigis-L\(^3\), OCT-based\(^4\), & Barrett True K\(^5\)

<table>
<thead>
<tr>
<th>Using ΔMR</th>
<th>Using no prior data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted EffRP</td>
<td>Wang-Koch-Maloneyn</td>
</tr>
<tr>
<td>Adjusted Atlas 9000 (4mm zone)</td>
<td>Shammas 23.20 D</td>
</tr>
<tr>
<td>Adjusted Atlas Ring Values</td>
<td>Haigis-L 23.27 D</td>
</tr>
<tr>
<td>Masket Formula 22.36 D</td>
<td>Galilei --</td>
</tr>
<tr>
<td>Modified-Masket 22.25 D</td>
<td>Potvin-Hill PentaCam --</td>
</tr>
<tr>
<td>Adjusted ACCP/ACP/APP</td>
<td>OCT --</td>
</tr>
<tr>
<td>Barrett True K 22.34 D</td>
<td>Barrett True K No History</td>
</tr>
<tr>
<td>Average IOL Power (All Available Formulas): 22.79 D</td>
<td></td>
</tr>
<tr>
<td>Min: 22.25 D</td>
<td></td>
</tr>
<tr>
<td>Max: 23.30 D</td>
<td></td>
</tr>
</tbody>
</table>
Pentacam
TNP_Apex_4.0 mm 42.45
Zone

Atlas Ring Values
0mm 1mm 2mm 3mm

OCT (RTVue or Avanti XR)
Net Corneal Power Posterior Corneal Power Central Corneal Thickness

Optical (IOLMaster/Lenstar)/Ultrasound Biometric Data:
Ks K1(D) 43.86 K2(D) 45.16 Keratometric Index (n)*** 1.3375 1.332 Other

AL (mm) 22.83 ACD (mm) 2.76 Lens Thick (mm) 4.68 WTW (mm) 12.79

Lens Constants**** A-const(SRK/T) 118.7 SF(Holladay 1) Haigis a0 Haigis a1
Haigis a2

* If entering "Sph(D)", you must enter a value for "Cyl(D)", even if it is zero.
** Most recent stable refraction prior to development of a cataract.
§ Magellan ACP or OPD-Scan III APP 3-mm manual value (personal communication Stephen D. Klyce, PhD).
** Select the version of your Galilei device: "V5.2 or earlier" or "V5.2.1 or later".
*** Select the keratometric index (n) of your device. Instruments in North America typically default to 1.3375.
**** Enter any constants available, others will be calculated from those entered. If ultrasonic AL is entered, be sure to use your ultrasound lens constants.

Please check Pre-LASIK/PRK refraction.

Calculate Reset Form

IOL calculation formulas used: Double-K Holladay 1, Shammas-PL2, Haigis-L3, OCT-based4, & Barrett True K5

Using zMR

1Adjusted EffRP -- 2Wang-Koch-Maloney --
2Adjusted Atlas 9000 (4mm zone) -- 2Shammas 23.20 D
1Adjusted Atlas Ring Values -- 3Haigis-L 23.27 D
Masket Formula 22.36 D 4Galilei --
Modified-Masket 22.25 D 2Potvin-Hill Pentacam 22.70 D
1Adjusted ACCP/ACP/APP -- 4OCT --
5Barrett True K 22.34 D 5Barrett True K No History 23.30 D

Average IOL Power (All Available Formulas): 22.78 D
Min: 22.25 D
Max: 23.30 D
*If entering "Sph(D)". you must enter a value for "Cyl(D)"; even if it is zero.
**Not manual/SimKs from other devices.
***Select the keratometric index (n) of your device. Instruments in North America typically default to 1.3375.
****Enter the constant available; the other will be calculated. If ultrasonic AL is entered, be sure to use your ultrasound lens constants.

### IOL Powers Calculated Using Double-K Holladay $1^\text{1}$, Shammas-PL $2^\text{2}$, & Haigis-L $3^\text{3}$

<table>
<thead>
<tr>
<th>Using Pre-LASIK/PRK Ks + $\Delta$MR</th>
<th>Using $\Delta$MR</th>
<th>Using no prior data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical History</strong> 25.76 D</td>
<td>$1^\text{Adjusted EffRP}$ --</td>
<td>$2^\text{Shammas}$ 21.94 D</td>
</tr>
<tr>
<td><strong>Feiz-Manns</strong> 25.76 D</td>
<td>$1^\text{Adjusted Atlas}$ 0-3</td>
<td>$3^\text{Haigis-L}$ 21.18 D</td>
</tr>
<tr>
<td><strong>Corneal Bypass</strong> 25.77 D</td>
<td>Masket Formula 21.99 D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modified-Masket 21.89 D</td>
<td></td>
</tr>
</tbody>
</table>

**Average IOL Power:** 23.47 D  
**Min:** 21.18 D  
**Max:** 25.77 D
### Pre-LASIK/PRK Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sph(D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyl(D)*</td>
<td></td>
<td>Vertex (If empty, 12.5 mm will be used)</td>
</tr>
<tr>
<td>K1(D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K2(D)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Post-LASIK/PRK Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sph(D)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Cyl(D)*</td>
<td>-0.50</td>
<td></td>
</tr>
<tr>
<td>Vertex(mm)</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

### Topography:

<table>
<thead>
<tr>
<th>Device</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EyeSys EffRP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlas 9000 4mm zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torrey ACCP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galilei TCP**</td>
<td></td>
<td>V5.2.1 or later</td>
</tr>
<tr>
<td>Pentacam TNP_Apex 4.0 mm Zone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Atlas Ring Values:

<table>
<thead>
<tr>
<th>Ring</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OCT (RTVue or Avanti XR):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Corneal Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Corneal Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Corneal Thickness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Optical (IOLMaster/Lenstar)/Ultrasound Biometric Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K1(D)</td>
<td>46.4</td>
<td></td>
</tr>
<tr>
<td>K2(D)</td>
<td>46.9</td>
<td></td>
</tr>
<tr>
<td>AL(mm)</td>
<td>22.13</td>
<td></td>
</tr>
<tr>
<td>ACD(mm)</td>
<td>2.94</td>
<td></td>
</tr>
<tr>
<td>Keratometric Index (n)**</td>
<td>1.3375 1.332 Other</td>
<td></td>
</tr>
<tr>
<td>Lens Thick (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTW (mm)</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>A-const(SRK/T)</td>
<td>118.4</td>
<td></td>
</tr>
<tr>
<td>Haigis a0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haigis a1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haigis a2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IOL calculation formulas used: Double-K Holladay 1\(^1\), Shammas-PL\(^2\), Haigis-L\(^3\), OCT-based\(^4\), & Barrett True K\(^5\)

<table>
<thead>
<tr>
<th>Using ΔMR</th>
<th>Using no prior data</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^1)Adjusted EffRP</td>
<td>(^2)Wang-Koch-Maloney</td>
</tr>
<tr>
<td>(^2)Adjusted Atlas 9000 (4mm zone)</td>
<td>(^2)Shammas 22.09 D</td>
</tr>
<tr>
<td>(^1)Adjusted Atlas Ring Values</td>
<td>(^3)Haigis-L 23.25 D</td>
</tr>
<tr>
<td>Masket Formula</td>
<td>(^1)Galilei --</td>
</tr>
<tr>
<td>Modified-Masket</td>
<td>(^2)Potvin-Hill Pentacam --</td>
</tr>
<tr>
<td>(^1)Adjusted ACCP/ACP/APP</td>
<td>(^4)OCT --</td>
</tr>
<tr>
<td>(^5)Barrett True K</td>
<td>(^5)Barrett True K No History 22.12 D</td>
</tr>
</tbody>
</table>

Average IOL Power (All Available Formulas): 22.49 D

Min: 22.09 D
Max: 23.25 D
IOL calculation formulas used: Double-K Holladay 1\textsuperscript{1}, Shammas-PL\textsuperscript{2}, Haigis-L\textsuperscript{3}, OCT-based\textsuperscript{4}, & Barrett True K\textsuperscript{5}

<table>
<thead>
<tr>
<th>Using ΔMR</th>
<th>Using no prior data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Adjusted EffRP</td>
<td>2Wang-Koch-Maloney</td>
</tr>
<tr>
<td>2Adjusted Atlas 9000 (4mm zone)</td>
<td>2Shammas 22.09 D</td>
</tr>
<tr>
<td>1Adjusted Atlas Ring Values</td>
<td>3Haigis-L 23.25 D</td>
</tr>
<tr>
<td>Masket Formula</td>
<td>1Galilei</td>
</tr>
<tr>
<td>Modified-Masket</td>
<td>2Potvin-Hill Pentacam 22.10 D</td>
</tr>
<tr>
<td>1Adjusted ACCP/ACP/APP</td>
<td>4OCT</td>
</tr>
<tr>
<td>5Barrett True K</td>
<td>5Barrett True K No History 22.12 D</td>
</tr>
</tbody>
</table>

Average IOL Power (All Available Formulas): 22.39 D

Min: 22.09 D

Max: 23.25 D
ASCRS Website calculator

- Using ΔMR- Beware in eyes with cataracts
- Cataracts can induce refractive error and as such can change the refraction
- If not considered- will get a surprise!
- Regression formulae usually quite accurate
- Exclude outliers and go for the average
- Put the print out in the notes
How to deal with a refractive surprise

• Be honest
• The management will depend on the degree of refractive error and whether hyperopic or myopic
• A -6.00 or +6.00 error won’t “heal”
• Small errors may be amenable to glasses wear
I’m not happy, what can you do for me?
PRK
LASIK
Supplementary Lens
IOL Exchange

Conclusions

• Anterior corneal curvature changes post-laser refractive surgery but posterior curvature stays the same

• Adjusted calculations need to be made to avoid refractive surprises

• Good pre-operative counselling is the key to maintaining a good relationship if there are surprises

• Set realistic expectations

• Explain what the options will be if there is an untoward outcome so there are no surprises
Conclusions

• Aim on the myopic side
• Consider doing the non-dominant eye first
• Formulas getting better and good evidence to support raytracing as a better tool in the future
• Use the ASCRS Calculator!
• Look for agreement between the formulae and exclude any outliers then average the rest
• For refractive surprise- aim for the least invasive option.
Thank You!