ASCRS ♦ ASOA Symposium & Congress

Technicians & Nurses Program

April 17-21, 2015 – San Diego, California
The Post-Refractive Surgery Keratometry Challenge

- Central cornea flattened for myopic correction, steepened for hyperopic correction
- Changes shape of cornea and refractive index of stroma unless RK
- Standard formulas using anterior corneal measurements assume a predictable relationship between front and back surfaces
- After LASIK, only the anterior surface is reshaped

Warn the Patient!

- These patients are at a higher risk of an imperfect result which could require yet another procedure for desired target refraction, i.e. more refractive surgery, an IOL exchange, a piggyback lens
- Tell them to expect two procedures from the beginning?

Clinical History Method

- Previously considered “Gold Standard”, but now one of least favored methods
- Requires records, no sign of cataract at time of refractive surgery and post-op
- Need three numbers:
  1. Pre-Op MR (sph eq)
  2. Pre-Op K’s (average)
  3. Post-Op MR (sph eq)

Clinical History Method

- Determine how much correction took place, then
  \[ K = \text{Pre-Op Avg. } K - \text{ change in MR} \]
Clinical History Method

For example:
- Average K pre-LASIK = 45.75 D
- - 5.00 D myope pre-LASIK
- - 0.25 D myope post-LASIK
- Change in MR = 4.75 D
- K = 45.75 D - (4.75 D) = 41.00 D

What If’s

- What if patient had enhancements or multiple types of procedures?
- The stable post-op refraction is the spherical equivalent after LAST PROEDURE

What If’s

- What if the patient had refractive surgery to correct hyperopia instead of myopia?
- ADD the amount of correction from original K rather than subtract due to corneal steepening

Clinical History Method

For example:
- Average K pre-Lasik = 42.75 D
- + 3.50 D hyperope pre-Lasik
- - 0.25 D myope post-Lasik
- Change in MR = 3.75 D
- K = 42.75 D + (3.75 D) = 46.50 D

The Most Reliable Methods Today

Shammas PL
For Myopic LASIK

- Measure K’s post-op (IOL Master or Sim K preferred), average, then
  \[ K = 1.14 \times (K \text{ post-op}) - 6.8 \]
- In his study, 93.3% within 1D of target
**Shammas PHL**  
*For Hyperopic LASIK*  

- Measure K’s post-op, average, and adjust with formula:

\[ K_c = 1.0457 \times (K_{\text{post-op}}) - 1.9538 \]

**Wang-Koch-Maloney Method**  

*For myopic LASIK patients:*

- Obtain topography post-op, then

\[ K = 1.114 \times (C_{\text{cp}}) - 6.1 \]

Where C_{cp} is the central corneal power with cursor at the exact center of the Axial Map  
Recommend using Atlas topographer

**Masket Method**  
Masket S, Masket SE. JCRS 2006; 32:430-434

- Best performance in some recent studies for PRK and LASIK patients (not RK!)
- Must know amount of correction from history (LSE = spherical equivalent of change after laser vision correction)

\[ \text{IOL Adjustment} = \text{LSE} \times (-0.326) + 0.101 \]

**Masket Formula Examples**  

*Prior Myopia (use SRK/T):*

- Formula yields +16.0 D
- LSE = -6.00 D
- \(-6.0 \times (-0.326) + 0.101 = +2.057\)
- \(+16.0 + 2.0 = +18.0 \, \text{D Final IOL Power}\)

*Prior Hyperopia (use Hoffer Q):*

- Formula yields +22.0 D
- LSE = +3.0 D
- \(+3.0 \times (-0.326) + 0.101 = -0.877\)
- \(+22.0 - 1.0 = +21.0 \, \text{D Final IOL Power}\)
**Modified Masket Method**

Warren Hill's data produced a slightly different regression formula when working to validate the Masket Method:

\[
\text{IOL Adjustment} = \text{LSE} \times (-0.4385) + 0.0295
\]

**Modified Masket Method**

Calculated IOL power = +15.26 D  
Stable SE correction after LASIK = -5.0 D  

Masket Method:  
\[(-5.0 \times -0.326) + 0.101 = +1.73 \text{ D}, \text{ so} \]
\[+15.26 \text{ D} + 1.73 \text{ D} = +16.99 \text{ D}\]

Modified Masket Method:  
\[(-5.0 \times -0.4385) + 0.0295 = +2.22 \text{ D}, \text{ so} \]
\[+15.26 \text{ D} + 2.22 \text{ D} = +17.48 \text{ D}\]

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**Haigis L**

- For both myopic and hyperopic LASIK on recent versions of IOL Master  
- Older versions have neither  
- Semi-older versions have myopic only  
- Use IOLM or immersion biometry, but IOLM K's only!

**Haigis L**

- For myopia, Haigis L has a correction function for IOL Master keratometry plus a correction factor for the ACD change (0.5 mm steeper since part of cornea removed) due to ablation – no history required  
- For hyperopia, since no ablation, has correction function for K’s only

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**Aramberri Double K**

Aramberri. JCRS 2003; 29(11):2063-2068

- Formulas actually use K’s twice: once regarding amount of power of cornea to bend light, the other to help predict ELP  
- With double-K modification, an avg K is inserted into the formula where ELP is predicted, adjusted K where corneal power is used  
- Axis II and Sonomed have double K

**Holladay II Double K Correction**

- Check the box in Holladay II for “Prev RK, PRK, LASIK” and it automatically puts avg K (43.9 D unless you provide historical information, then will use that) in ELP prediction
Prior Myopic LASIK/PRK

Previous Calculator Version

- Typically first column much stronger than second and third

New Version

- Best results from Masket, Shammas, Haigis-L, and Wang-Koch-Maloney, Potvin-Hill, Barrett
- Completely eliminated first column!
Potvin-Hill Pentacam Method

- For myopic LASIK only
- Directly determines the corneal power by measuring both the anterior and posterior surfaces with the Pentacam rotating Scheimpflug camera
- Best results were found to be from using the true net power measurements in the 4.0 mm zone centered on the corneal apex (TNP_Apex_Zone_40), used in Shammas formula

Barrett True K Method
Barrett GD. True-K formula: New Approach to biometry after LASIK. Presented at ASCRS 2009

- For myopic LASIK, hyperopic LASIK, and RK
- Based on Barrett Universal II formula
- Calculates a modified K value for post-refractive patients
- Requires optical Ks as measured and the pre- and post-refractive surgery refractions for maximum accuracy
- Can also be run when no history available

OCT-Based Method

- For myopic LASIK, hyperopic LASIK, and RK
- Net corneal power, posterior corneal power, and central corneal thickness are obtained from RTVue or RTVue-XR (Optovue Inc)
- Axial length and ACD from IOL Master
- Recommended to perform three OCT scans and use the median net and posterior corneal power
Prior Hyperopic LASIK/PRK

RK Patients

- History method not as good for post-RK due to unstable post-op refraction
- Measure them in morning rather than afternoon – K’s flatter in the am, steeper in pm
- Make them plano in the am, myopic in pm – not hyperopic am, plano pm!
**Disadvantages of ASCRS Calculator**

- No power ranges from which to choose
- Can only run for one IOL on the page, so must run multiple times for different IOLs

**Emory Protocol for Post-Refractive Patients**

- Run ASCRS Calculator, but also:
  - Adjust K’s with Shammas Method manually and enter into Holladay II formula as “Surgeon entered adjusted K”
  - Check box that patient had prior refractive surgery so it functions as a double K formula!

**Emory Protocol for Post-Refractive Patients**

- Now docs have all four lenses calculated on the page
- Now they have power ranges from which to choose
- Holladay II may differ a little from ASCRS calculator of same method because more of the eye anatomy being considered than Holladay I formula being used in calculator

**Emory Protocol for Myopic LASIK Patients**

For Holladay II:

- Manually calculate Ks by Shammas PL
- IOLM K’s: 40.66/41.26
- Average those Ks (add them together, then divide by 2)
- Avg K = 40.96
- Shammas PL = 1.14 (40.96) – 6.8
- Adj K for calcs = 39.89

**Emory Protocol for Myopic LASIK Patients**

- Adjusted K of 39.89 entered into H II
- Checked box that patient had prior refractive surgery
- IOL Power = 17.50 D
- Post-Op outcome:
  -0.75 + 0.50 x 176 = 20/20
**Emory Protocol for Hyperopic LASIK Patients**

- AEL: 22.26 OS by optical
- IOLM K's: 46.18/47.02 OS
- Targeted plano OS

**For Holladay II:**
- Manually calculate K's with Shammas PH
- IOLM K's: 46.18/47.02
- Average those Ks (add them together, then divide by 2)
- Avg K = 46.60
- Shammas PH = 1.0457 (46.60) - 1.9538
- Adj K for calcs = 46.77

**Emory Protocol for Hyperopic LASIK Patients**

- Adjusted K of 46.77 entered into H II
- Checked box that patient had prior refractive surgery
- IOL Power = 20.0 D
- Post-Op outcome: plano = 20/20

**Emory Protocol for RK Patients**

- AEL: 22.99 OD, 22.79 OS
- IOLM K’s: 43.55/44.35 OD
  44.41/44.88 OS
- Target -0.75 OU

**For Holladay II:**
- Enter as normal so program will average
- IOLM K’s OD: 43.55/44.35 (avg 43.95)
- IOLM K’s OS: 44.41/44.88 (avg 44.65)
- Check box that patient had prior refrsx
- IOL Power = 22.5 D OU
- Post-Op outcome: OD: -1.00 + 1.00 x 175 = 20/20
  OS: -0.50 = 20/15-1
Patient Unsure

- Patient had LASIK OU, wasn’t sure what type
- Asked if she was nearsighted or farsighted beforehand
- Her answer was “both”

Topography
Myopic LASIK

- Flat zone centrally

Topography
Hyperopic LASIK

- Steep zone centrally

CAUTION!!!

- ALL methods require good data in!
- If measurements are not accurate, none of the methods work!
- Must use ultrasound for long eyes!

We must first get the correct axial length!

- Eyes 25.0 mm or longer: Optical tends to measure long eyes too long – hyperopic surprises reported - do immersion and B-scan biometry to verify
Long Eye: Optical vs. Ultrasound

<table>
<thead>
<tr>
<th>AL (mm)</th>
<th>Optical</th>
<th>Ultrasound</th>
</tr>
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<tbody>
<tr>
<td>28.51</td>
<td>28.37</td>
<td>28.10</td>
</tr>
<tr>
<td>28.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post-op using Imm:
OD: -0.75 +1.25 X 140 (SE = -0.125)
OS: -0.50 + 0.50 X 008 (SE = -0.25)

Optimizing Axial Length in Long Eyes


- Holladay I formula:
  \[0.8814 \times AL_{(IOLM)} + 2.8701 = \text{Adjusted AL}\]
- Haigis formula:
  \[0.9621 \times AL_{(IOLM)} + 0.6763 = \text{Adjusted AL}\]
- SRK/T formula:
  \[0.8981 \times AL_{(IOLM)} + 2.5637 = \text{Adjusted AL}\]
- Hoffer Q formula:
  \[0.8776 \times AL_{(IOLM)} + 2.9269 = \text{Adjusted AL}\]

Optimizing Axial Length in Long Eyes

- The problem with using an optimization equation is that sometimes optical gets it right!
- Adjusting a measurement that didn’t need adjusting will still lead to a post-op surprise
- The best way to measure the high myope is with ultrasound so you know it is correct

Immersion Technique

- Probe immersed in shell of saline
- Most accurate/no corneal compression (0.015 - 0.05 mm depending on manufacturer)
- The method to which optical was calibrated in its development

Why High Myopes are Harder to Measure

- The eye is misshapen, oval or elongated rather than round
- Macula on a “slope”
- Perpendicularity impossible
**Posterior Staphyloma**

- Uvea bulging into thin, stretched sclera
- Commonly in posterior pole
- Perpendicularity impossible
- Measurements vary greatly

**B-Biometry Technique**

- Align B-scan with "HMAC" position (probe on corneal vertex, marker nasal) with 4 or 5 mm of gel on probe tip
- Corneal vertex and posterior lens surface centered on left, macula centered on right inferior to optic nerve
- Macula ~4.5 mm down from center of optic disc
- Place one caliper on front of cornea, move the other through the center of the lens to macular surface

**If you don’t see the cornea, you aren’t using enough gel!**

**B-Biometry Technique Comparison to Good Immersion**

- 23.78 on A-scan
- 23.80 on B-scan

**Conclusion**

- Records will continue to be difficult to obtain, research emphasis being placed on methods that don’t require history
- Keep up with the latest methods
- Use ASCRS calculator
- Know which methods are most reliable
- Don’t forget to get ultrasound measurements on the long eyes!
- Do NOT measure the cornea after an eye exam!
- ALL methods require good data in!