IOL Formula Performance in Infantile Eyes from the Infant Aphakia Treatment Study

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IOL Calculation Challenges in Infants

• Patient
  — Lack of cooperation
  — Extremely small eyes
  — Dense cataracts
  — Anatomic abnormalities and variations

• Equipment limitations
  — Difficulty with high or low measurement extremes
  — Inability to use optical coherence biometry

Understanding these many possible errors in the infant population, how can we choose the best IOL calculation formula?

Comparison of IOL calculation formula performance

Prediction Error (PE):

Predicted Refraction - Actual Refraction
|Predicted Refraction – Actual Refraction|

PE and commonly used IOL Calculation formulas

Adult studies suggest

• Theoretic formulas perform equally well for eyes of axial length 22.0-26.0+ mm (PE: 0.25D)

• Holladay, Hoffer Q, Haigis yield lowest PE for eyes < 22.0 mm (PE: 0.25-0.50)

• Very few studies with eyes of AL <20mm

• Most recent publications include use of optical coherence biometry and optimized constants
PE in pediatric populations

• Studies limited by variations in biometry; generally shorter eyes
  – Still limited number of short eyes

• Association of higher PE with shorter AL
  – Typical absolute PE: 0.7D-1.5D

PE for Infant Aphakia Treatment Study (IATS) Eyes

Predictability of Intraocular Lens Calculation and Early Refractive Status

The Infant Aphakia Treatment Study


PE for IATS Eyes

• Analysis of 43/56 infant eyes
  – Standardized surgical technique
  – SN60AT IOL
  – Holladay 1 formula
  – Capsular bag implantation
  – Validated biometry
    • Baseline AL: 18.1 ± 1.1 mm
    • Baseline K: 46.2 ± 2.5 D
  – One month refraction
  – Glaucoma/glaucoma suspect eyes excluded

PE for Infant Aphakia Treatment Study (IATS) Eyes

Holladay 1
• Mean absolute PE: 1.8 ± 1.3 D
• Mean PE: +1.0 ± 2.0 D
  – Most eyes achieved less hyperopia than expected

Which formula could have performed best for IATS cohort?

Absolute PE (diopters) by formulas for IATS eyes

<table>
<thead>
<tr>
<th>Formula</th>
<th>Mean ± SD</th>
<th>Median (1st Quartile, 3rd Quartile)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoffer Q</td>
<td>2.6 ± 2.0</td>
<td>(0.7,4.0)</td>
</tr>
<tr>
<td>Holladay 1</td>
<td>1.7 ± 1.3</td>
<td>(0.7,2.5)</td>
</tr>
<tr>
<td>Holladay 2</td>
<td>1.9 ± 1.5</td>
<td>(0.6,2.9)</td>
</tr>
<tr>
<td>SRK/T**</td>
<td>1.4 ± 1.1</td>
<td>(0.3,2.1)</td>
</tr>
<tr>
<td>SRK II*</td>
<td>2.4 ± 1.8</td>
<td>(0.9,3.6)</td>
</tr>
</tbody>
</table>

* SRK/T = Sanders-Retzlaff-Kraff Theoretic; SRK II = Sanders-Retzlaff-Kraff II
** Paired comparison of medians; SRK/T and Holladay 1 similar
What about other formulas?

<table>
<thead>
<tr>
<th>Formula</th>
<th>Mean ± SD</th>
<th>Median (1st/3rd quartile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haigis (n=33)</td>
<td>3.5 ± 2.2</td>
<td>3.5 (1.4, 5.1)</td>
</tr>
<tr>
<td>Hoffer Q</td>
<td>2.6 ± 2.0</td>
<td>2.1 (0.7, 4.0)</td>
</tr>
<tr>
<td>Holladay 1</td>
<td>1.7 ± 1.3</td>
<td>1.2 (0.7, 2.5)</td>
</tr>
<tr>
<td>Holladay 2</td>
<td>1.9 ± 1.5</td>
<td>1.4 (0.6, 2.9)</td>
</tr>
<tr>
<td>Olsen (n=33)</td>
<td>2.2 ± 1.7</td>
<td>1.6 (0.9, 3.3)</td>
</tr>
<tr>
<td>SRK/T*</td>
<td>1.4 ± 1.1</td>
<td>1.3 (0.3, 2.1)</td>
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<td>SRK II*</td>
<td>2.4 ± 1.8</td>
<td>2.2 (0.9, 3.6)</td>
</tr>
<tr>
<td>T2</td>
<td>1.3 ± 1.0</td>
<td>1.1 (0.5, 2.0)</td>
</tr>
<tr>
<td>Universal</td>
<td>3.0 ± 2.2</td>
<td>2.8 (1.1, 4.7)</td>
</tr>
</tbody>
</table>

*SRK/T = Sanders-Retzlaff-Kraff Theoretic; SRK II = Sanders-Retzlaff-Kraff II

What is the T2 formula?

**ARTICLE**

Improving the prediction accuracy of the SRK/T formula: The T2 formula

Richard M. Sharda, MD, FRCOphth, Gay T. Smith, FRCOphth, David L. Corder, MD

Purpose: To investigate the causes of non-physiologic behavior of the SRK/T formula, assess their clinical significance, and develop an improved technique.


What about optimization?

- Non-physiologic behavior of IOL calculation using SRK/T occurs with
  - Corrected AL calculation (>36.2 mm)
  - Corneal cusp phenomenon: errors in prediction of corneal height with high keratometry values
  - New corneal height regression formula

- Personalized constants most reliable
- Data should come from similar surgical technique, surgeon, biometry type, IOL type and implantation style
- Should have high number of cases
- When optimization was possible for IATS eyes, formulas performed better with less difference, but order of performance similar
IOL Calculation Formula Performance: Take home points

- Minimize all sources of error—realize that formula performance depends on accurate input
- Use a theoretic formula, compare IOL calculation formula results
  - Understand direction of error for a formula and impact based on child's age and baseline AL
  - Higher PE and undercorrection are more common for very short/infant eyes

Thank you