Hill-RBF Method

Summary
This white paper showcases how the Hill-RBF Method works and how it performs against other IOL power calculation techniques.

Why RBF
Cataract surgery no longer only cures the cataract but becomes more and more a refractive procedure with the aim of spectacle independence. Still benchmark data shows that outcomes within +/- 0.5D are achieved only in 50 to 80% of the cases. Therefore there is room for 20% and more improvement.

Limitation of current formulas
The proverbial Achilles-Heel of all current IOL calculation formulae is that they’re all based on an eye-model and therefore need to estimate the implant position (ELP) for the IOL calculation and this parameter is not available pre-operatively. Standard 2nd generation IOL calculation formulae like HofferQ, Holladay or SRK/T estimate the lens position based on axial length and K measurements, assuming that long eyes as well as steep corneas lead to a deep lens position and vice versa. This assumption is the reason why all of these formulae provide weak performance with extreme eyes, because the vast majority of long as well as short eyes show normal anterior chamber dimensions and are not deep or shallow as assumed by the formulae.

What is RBF and how does it perform
The new Hill-RBF Method is a pure data driven IOL calculation approach and therefore it is free of the limitation of lens-position estimation. RBF stands for Radial Basis activation Function. It is driven by an advanced, self-validating method using pattern recognition based on artificial intelligence and sophisticated data interpolation. Starting with a large number of cases where the biometry and the outcomes are known, RBF is capable to find distinct patterns in the apparently random cloud of data-points. This technology is in wide use and allows law enforcement agencies to recognize faces on surveillance tapes, it is part of the finger print recognition with your mobile phone and it is used in the ECG analysis to identify potential stroke candidates. The current algorithm is based on outcome data of more than 3400 eyes, with Lenstar biometry data and the Alcon SN60WL IOL implanted. It works best with this combination of biometry device and IOL but works also very good with biometry data from other optical biometry devices and with other biconvex IOL’s from +6 to +30D.

<table>
<thead>
<tr>
<th>Dimension matrix of the human eye: axial length vs. anterior segment size⁴.</th>
<th>Anterior Segment Size</th>
<th>Axial length</th>
<th>normal (76%)</th>
<th>Long (15%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>large</td>
<td>Megalocornea, axial hyperopia</td>
<td>0%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>normal</td>
<td>Axial hyperopia</td>
<td>6.9%</td>
<td>73.4%</td>
<td>13.5%</td>
</tr>
<tr>
<td>small</td>
<td>Small eye, nanophthalmia</td>
<td>1.8%</td>
<td>1.5%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Microcornea</td>
<td>1.5%</td>
<td>1.5%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Microcornea, and axial myopia</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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</tbody>
</table>

Outcome data of a worldwide multicentre retrospective clinical trial involving data from 13 surgeons located in 8 countries. Weighted mean shows that 95% of the patients reached +/- 0.5D of predicted refractive accuracy. In Dr. Hill’s IOL constant optimisation data set, featuring more than 250’000 cases less than 1% of the surgeons reach 92% within +/- 0.5D.

Result of the first prospective multicentre clinical trial including more than 440 cases from three study centres. The graph shows the detail results for the most demanding subpopulation, the short eyes. The Hill-RBF Method outperformed statistically significant all 2nd and 3rd generation formulae as well as Holladay 2 and it performed slightly better than Olsen and the Barrett Universal II formula.

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In a first prospective trial as well as in several retrospective studies the Hill-RBF Method demonstrated its performance to be equivalent or better than latest generation IOL calculation formulae like Olsen or Barrett[^5,^6]. It further outperformed all 2nd and 3rd generation formulae like Haigis, HofferQ, Holladay or SRK/T. In a retrospective multicenter trial throughout the world involving data from 13 surgeons from 8 countries; RBF did prove that it works independently of the patient population specific features. It is pure data driven and therefore free from limitations inherent to standard formulae.

The Hill-RBF Method can be used for all biconvex IOL’s from +6.00D to +30.00D independent of the eyes anatomy (short, average, long). It is optimized for the use with Lenstar biometry measurements but may also be used with data from other devices providing clinically equivalent measurement data.

**RBF is the only IOL calculation method that knows its limits**

In addition to its excellent performance, the Hill-RBF Method is the only IOL calculation approach that provides the surgeon with information on the reliability of the result provided. The Hill-RBF Method incorporates a boundary model that allows calculation of the prediction dependability. Reliable calculation results are labeled with “In Bounds”, results that deserve more attention of the surgeon, since the prediction algorithm was not able to determine the desired level of reliability, are labelled “Out of Bounds”. An out of bounds labeled result does not need to be inaccurate but the Hill-RBF Method informs the surgeon that the respective pattern of biometric measurements is not well studied by the algorithm and it is recommended to use the Olsen and the Barrett formula to confirm the proposed IOL. For the first time in the history of IOL calculation, Hill-RBF provides the user with this unique safety feature.

**Excellent already and getting better and better**

Last but not least another advantage is achieved through the process of adaptive, dynamic learning. Unlike static theoretical formulae, the Hill-RBF Method is an ongoing project and is continuously updating (annual updates planned) - the higher the number of surgical outcomes entered into the RBF model, the better the overall depth of accuracy and broader its application boundaries will get.

**Take home messages:**

- The Hill-RBF Method is a new paradigm in for IOL power calculation, featuring pattern recognition and sophisticated data interpolation leading to improved IOL prediction accuracy.
- The Hill-RBF Method performs equally well on all eyes; short, average and long ones, independent of specific anatomical features.
- It learns and improves with increased data available. In its current release it works for biconvex IOL’s from +6.00D to +30.00D with optical biometry data from sources providing measurements equivalent to the Lenstar.
- The Hill-RBF Method is the first IOL calculation approach that informs the user if a result may be inaccurate.

**References:**

5) Hill W.E. IOL Power Selection by Pattern Recognition; ASCRS EyeWorld Corporate Education; ASCRS 2016
6) Snyder M.E. The Hill-RBF Calculator in Clinical Practice; ASCRS EyeWorld Corporate Education; ASCRS 2016

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