ACCURACY OF IOL POWER CALCULATION FORMULAS


And the winner is ....

BY KARLA ORSINE MURTA DIAS, MD, AND ANDREW M.J. TURNBULL, BM, PGDIPCRS, FRCOPHTH

STUDY IN BRIEF

▶ A retrospective big data study compared the prediction errors of a variety of IOL power calculation methods using biometry. The recently described Kane formula was found to be the most accurate, both overall (72% within ±0.50 D of target) and in each subgroup of short, normal, and long eyes. Overall refractive accuracy was less than that reported by other investigators, reflecting the heterogeneous, multisurgeon nature of the data set and unavailability of some biometric parameters known to improve formula performance.

WHY IT MATTERS

Many factors influence the refractive outcome of cataract surgery, including ocular anatomy, surgeon experience, and IOL technology, but underpinning the process are accurate IOL power calculations based on precise biometry. The researchers compared formula accuracy with biometric parameters limited to axial length, keratometry, and anterior chamber depth. The study offers useful information to surgeons who lack access to the latest biometric technology. It also highlights the gap in outcomes between the United Kingdom National Health Service with the IOLMaster 500 (Carl Zeiss Meditec) and what is achievable in optimal settings (> 90% within ±0.50 D).

ASSESSMENT OF THE ACCURACY OF NEW AND UPDATED INTRAOCULAR LENS POWER CALCULATION FORMULAS IN 10 930 EYES FROM THE UK NATIONAL HEALTH SERVICE

Darcy K, Gunn D, Tavassoli S, Sparrow J, Kane JX[1]
Industry support: No

ABSTRACT SUMMARY

For this large database analysis from two centers in the United Kingdom National Health Service, investigators compared the accuracy of new or updated IOL power calculation methods (Kane, Hill-RBF 2.0, and Holladay 2 with the recent axial length adjustment [Holladay 2-AL]) to that of established techniques (Barrett Universal II, Olsen, Haigis, Holladay 1, Hoffer Q, and SRK/T). This retrospective study included 10,930 eyes of the same number of patients from consecutive cases of uneventful phaco cataract surgery.

Using biometry (IOLMaster 500, Carl Zeiss Meditec) and optimized IOL constants, the researchers determined the prediction error for each eye by subtracting the predicted postoperative refraction for each formula from the achieved subjective refraction at 4 weeks. A subgroup analysis based on the axial length (AL) and IOL model was also performed.

The investigators found the Kane formula to be the most accurate overall. Results according to mean absolute error in each AL subgroup are shown in the Table.

TABLE. ACCURACY OF IOL FORMULAS ACCORDING TO MEAN ABSOLUTE ERROR

AXIAL LENGTH	ACCURACY*
Short (< 22 mm)	Kane < [Holladay 2-AL; Olsen; Holladay 1; Hill 2.0; Hoffer Q] < [Haigis; SRK/T; Barrett]
Medium (22–26 mm)	Kane < [Hill 2.0; Olsen; Barrett; Holladay 2-AL; Holladay 1] < [SRK/T; Hoffer Q; Haigis]
Long (> 26 mm)	Kane < Barrett < [Hill 2.0; Olsen; Holladay 2-AL] < Haigis; SRK/T < [Hoffer Q; Holladay 1]

*Formulas that performed similarly statistically are grouped together.

DISCUSSION

This is the first study to compare

the recently described Kane formula to the updated Hill 2.0 and Holladay 2-AL formulas. The Kane formula performed best across the board, but the updated Hill-RBF and Holladay 2-AL formulas represent significant improvements. These are exciting developments. Of note, according to these results, older formulas such as the SRK/T no longer represent best practice. For short eyes, several methods outperformed the Hoffer Q, which has traditionally been viewed as the preferred option.

A limitation of this study is its reliance on biometry performed with the IOLMaster 500, which cannot provide parameters such as lens thickness, white-to-white distance, or pachymetry. These measurements are known to improve the performance of the formulas that include them, so the order of accuracy would almost certainly change if the measurements were available. The Kane, Olsen, Barrett, Holladay 2, and Hill 2.0 formulas would perform better to varying degrees, whereas the SRK/T, Haigis, Holladay 1, and Hoffer Q formulas would perform similarly. Nonetheless, the study offers useful information to surgeons who lack access to modern biometry machines. Those with such access, however, should exercise caution if applying these results.

COMPARISON OF FORMULA ACCURACY FOR INTRAOCULAR LENS POWER CALCULATION BASED ON MEASUREMENTS BY A SWEPT-SOURCE OPTICAL COHERENCE TOMOGRAPHY OPTICAL BIOMETER

Savini G, Hoffer KJ, Balducci N, Barbioni P, Schiano-Lomoriello D[2]

Industry support: No

ABSTRACT SUMMARY

The goal of this prospective analysis of 150 consecutive eyes was to determine the utility of a swept-source OCT (SS-OCT) biometer (OA-2000, Tomey) by using its measurements in an evaluation of multiple IOL power calculation methods (Barrett Universal II, Emmetropia Verifying Optical, Haigis, Hill-RBF 2.0, Hoffer Q, Holladay 1, Holladay 2 with and without the new axial length adjustment algorithm, Kane, Olsen, Panacea, SRK/T, T2, and VRF). The refractive outcomes of some of these formulas had not been published previously in the peer-reviewed literature.

The predicted postoperative refraction for each eye was calculated for each method, either via a validated spreadsheet or by the formula authors themselves, using IOL constants optimized for the data set. Prediction errors were determined in the usual fashion, and all formulas benefitted from a complete set of both essential and optional input parameters.

The data set comprised mainly eyes that had a normal AL (22–26 mm), with the AL of only 19 eyes greater than 26 mm and three eyes shorter than 22 mm. All eyes were operated on and subsequently refracted by the same surgeon using a standardized technique.

The investigators concluded that, as all formulas produced prediction errors within ±0.50 D in at least 80% of the eyes, measurements from the OA-2000 permit reliable IOL power calculation. The Kane, Hill 2.0, and Emmetropia Verifying Optical formulas all achieved better than 90% accuracy within ±0.50 D of target, although the Hill 2.0 was prone to occasional far outliers. The Barrett, Holladay 2-AL, and T2 formulas achieved at least 88% accuracy with no far outliers. Older vergence formulas also performed well, with 84.67% to 85.33% achieving ±0.50 D of target. This striking improvement over other published reports was explained by the robust single-surgeon data set and relative lack of short eyes.

STUDY IN BRIEF

- A prospective study of 150 eyes was designed primarily to determine the utility of swept-source OCT biometry with the OA-2000 (Tomey), but it also evaluated the performance of several modern formulas, all with their full complement of biometric parameters.

Accuracy within ±0.50 D of the refractive target was achieved in 80% to 90.67% of eyes. The Kane, Hill 2.0, and Emmetropia Verifying Optical formulas achieved at least 90% accuracy, and the Barrett, Holladay 2 with the adjusted axial length algorithm, and T2 formulas achieved at least 88%. Traditional vergence formulas also performed well, showing that they continue to be valid options in certain settings.

WHY IT MATTERS

This study demonstrates the value of using the latest generation of IOL calculation methods and swept-source OCT biometry. Traditional vergence formulas still have a place: Most biometry machines have them onboard, thus requiring no data entry (with the associated risk of transcription errors), and their IOL constants are easily optimized. Nevertheless, newer methods offer greater precision and virtually eliminate large refractive surprises in normal to long eyes.

In the subgroup of long (> 26 mm) eyes, both the Kane and Hill 2.0 formulas achieved 94.74% accuracy within ±0.50 D of target. The Olsen standalone, T2, and Emmetropia Verifying Optical formulas all achieved 89.47%.

DISCUSSION

This study provides important information despite its use of a relatively small, homogeneous data set. This research offers further evidence that many of the newer IOL calculation methods provide superior refractive outcomes compared with traditional vergence formulas and suggests that SS-OCT represents the new gold standard in biometry. The study also confirms the significant improvement in the Holladay 2-AL; this is one of the most accurate formulas currently available.

The investigators make the important point that, although traditional formulas may not reach the heights of newer methods, the former remain valid options. This is relevant to the current United Kingdom National Institute of Health and Care Excellence guidance, for example, in which the Barrett formula is recommended only if built into the biometer so as to avoid transcription errors. Otherwise, this guidance advocates the continued use of the SRK/T, Haigis, and Hoffer Q formulas. Another advantage is the relative ease with which the IOL constant optimization process can be performed with vergence formulas.

In the context of refractive cataract surgery, ophthalmologists are striving for excellence. To achieve it, this study and the aforementioned one by Darcy et al[1] suggest that surgeons should adopt the best-performing formulas and ensure the most accurate biometric measurements. There is a group of high-performance methods that seem suitable for most eyes, and SS-OCT currently appears to offer the greatest accuracy and versatility in biometry. ■

1. Darcy K, Gunn D, Tavassoli S, Sparrow J, Kane JX. Assessment of the accuracy of new and updated intraocular lens power calculation formulas in 10 930 eyes from the UK National Health Service. *J Cataract Refract Surg*. 2020;46(1):2-7.
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