Commentary: Newer insights into methods of intraocular lens power calculation

Intraocular lens (IOL) power selection is undoubtedly the most critical step towards achieving an optimized outcome in cataract surgery. Last decades have witnessed the emergence of several generations of IOL power calculation formulae. Despite the advent of sophisticated prediction models, the level of accuracy continues to depend on numerous factors; reflecting distinct anatomical and optical characteristics of the human visual system. Current concept of IOL power calculation largely depends on accuracy of following parameters such as axial length (AXL), keratometry (K), predictability of effective lens position (ELP), anterior chamber depth (ACD), A-constant, lens thickness (LT), white-to-white (WTW) diameter, previous refractive surgery, and patient’s age.

Modern surgical techniques provide refractive correction often within +/-0.50 D (dioptre) of the targeted spherical correction.[1,2] Furthermore, the presence of corneal astigmatism remains a significant barrier towards achieving an optimized outcome. Therefore, tackling preexisting astigmatism and minimizing surgically induced astigmatism (SIA), remain important considerations towards achieving emmetropia. In addition, SIA helps in planning the surgical incision to minimize postoperative astigmatism.

Latest advancements in surgical techniques are complemented by newer IOL power calculation methods which are further combined with modern IOL designs that have changed the nature of cataract surgery akin to a refractive procedure. Multiple theories have been put forth to arrive at a consensus formula to calculate IOL power that provides maximum accuracy. These include regression and vergence methods, employing “thin lens” and “thick lens” models as well as ray-tracing methods.[3-5]

First and second-generation formulae based on regression studies have performed reasonably well in patients with average biometry. By altering A-constant according to axial length in the second-generation formula, results have improved significantly. However, the term “A-constant” appears misleading since it varies among IOL models and even among surgeons; thus keeping these formulae far from perfection. The concept of ELP was introduced in the third-generation IOL formulae as part of the refractive vergence calculation. The ray-tracing formula has an advantage over standard vergence formula, in that it takes into account the asphericity of the cornea and the lens implant.[6,7] However, it is to be noted that even ray-tracing formulae have not achieved their full potential owing to their dependence on the precise estimation of ELP for IOL power calculation.

Consequently, no single formula has been uniformly appropriate for all eyes, primarily due to the incorporation of multiple variables in a single formula. This provides us with a set of formulae, where each is more appropriate for a given range of axial length than the other.[3,5] The Hoffer-Q formula is most accurate in eyes with a shorter AL while SRK/T and Haigis formulae are better suited for eyes with longer AL. The accuracy of these formulae may differ according to the

ACD, even in eyes with the same AL and keratometry.[1,4] Haigis formula incorporated in the IOL Master® (Carl Zeiss Meditec) is a fourth-generation formula that considers AL and preoperative ACD to predict ELP.

The new “bicylindric IOL power calculation method”, based on steep and flat corneal meridians, claims to predict refractive outcomes with greater accuracy than the Haigis formula in patients with low corneal astigmatism.[7] Bicylindric method showed an improvement in predicting refractive outcome up to 8% more accurately than the classical method.[8] At 4 weeks postoperatively, the mean difference between spherical equivalent predicted by Haigis formula and that achieved was -0.117 D, as opposed to -0.054 D by bicylindric method.

The rationale behind this improved predictability and accuracy, as explained by Calvo-Sanz et al. follows that IOL power calculation is generally performed using biometry measurements such as mean keratometry, axial length and various regression formulae to achieve emmetropia as spherical equivalent; whereas the bicylindric method employs both keratometry readings (K1 and K2) to improve the reliability and prediction of refractive outcome.

Agreeably corneal astigmatism is a vector quantity comprising of both magnitude and direction, thus simple algebraic sum will not yield accurate values. Therefore, the inclusion of SIA becomes imperative during IOL power calculations. The bicylindric method serves to obtain greater correlation with spherical equivalent as well as sphero-cylindrical refraction in the intraclass correlation coefficient with the sphere, cylinder, and axis. The advantage of the referenced method lies in the fact that the calculation of IOL power for both steep and flat meridians provides two refractive outcome predictions. The expected final refraction being in sphero-cylindrical format provides higher accuracy with respect to expected residual refraction postoperatively, in terms of sphere/cylinder/axis instead of only spherical equivalent.

Designing a perfect IOL power calculation formula which possesses more than 95% predictability will always be a complex issue and is being continuously improved upon by the collaborative endeavours of ophthalmologists, physicists, and mathematicians. Undoubtedly these formulae remain an essential backdrop against which a successful cataract and refractive outcome can be envisaged. The efforts of Jorge et al. is a commendable step further in this direction. However, this concept needs validation in larger groups of homogenous subjects to further improve upon the determinants. More studies in this aspect would serve not only to corroborate the predictability of results but will further give deeper insights into the use of this new application in pursuit of goal towards achieving emmetropia for every eye.

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