HIGH PRECISION BIOMETRY: Avoiding surprises in Cataract surgery

Dr. Rajesh Kapoor, Dr. Ajay Dudani, Dr.Vinod Goyel

This article, culled from various sources, provides a good summary of the current state of biometric techniques

INTRODUCTION:

Pre- operative biometry has a major influence on the success or failure of IOL implantation procedures. The field is evolving rapidly, driven by a new understanding of the Anatomy of the eye and new hardware for measuring that Anatomy. Software tools derived from enhanced formulas are also helping to improve accuracy in predicting outcomes with the growing number of IOLs in the market. An increasing number of patients who had **RK** ten or more years ago are now showing up for Cataract procedures, as are patients who have undergone **PRK and LASIK**. These patients pose a whole new set of biometric challenges. This article reviews these and related issues facing biometry today.

HOW TO DO PRECISE BIOMETRY:

From the patient perspective, the uncorrected visual acuity is the main measure of the operation success; of course excellent surgical technique is required for optimal visual out come; but accurate eye measurement are important in preventing refractive surprises.

Several values are required to calculate IOL Power

- Accurate Corneal power
- Actual axial length
- Accurate prediction of estimated lens position (half a mm shift in lens position can have a dramatic effect on final vision)
- Desired post op refraction
- A good understanding of the various IOL Power calculation formulas is also required.
- It is very important to discuss with patients their postoperative refractive expectations.

KERATOMETRY:

- 1 D error in keratometric reading would lead to 0.9 D error in the calculation of IOL Power.
- Gonioscopy and Tonometry before Keratometry should be avoided as it distorts the mires.
- Putting Artificial tears before doing this is useful.
- For measuring vertical and horizontal plane go for '+ mire' alignment instead of '- mire' as it gives better result.
- Correlate keratometric reading with your refractive reading if you are able to refract these patients
  In case there is a difference in cylinders between your refraction and keratometry than go for corneal Topography (if facility is there) and compare. If keratometry and topography correlates then cylinder is due to lenticular astigmatism, which will be taken care once lens is removed; or else repeat Keratometry.
- Using same keratometer produces a consistent error, and that error can be factored when the 'A' constant is being personalized.
- Keratometry in post –RK / LASIK patient is discussed later.

MEASURING AXIAL LENGTH:

- 1-mm error in measurement of axial length produces an error of 3 D in IOL calculation.
- **Which reading to choose**: You have to look at the A Scan graphs. If the spike from retina is not followed by multiple small spikes that means you are hitting optic nerve, so delete that record.
- If there is a reading where the anterior chamber depth and actual length reduces, it indicates that in that particular reading you are compressing the cornea. So delete that reading.
- Rest take account of all the other readings.
- The most common mismeasurement occurs when measuring long eyes. Ultrasound measures to the deepest point of the posterior pole, but the fovea in the long eye is rarely at that point.
  In eyes more than 26 mm in size there is posterior staphyloma. Ultrasound measures anatomical axial length rather than optical axial length to the fovea. The difference between the two can be of 3 mm and this can produce a refractive surprise of upto 9 D.
- These errors can be minimized by doing OPTICAL BIOMETRY with IOL Master (discussed later), which is a recent development.

WHICH FORMULA TO CHOOSE:

In general: -

1. Every surgeon should personalize his A – Constant.
2. SRK-2 works well between axial length 21-26 mm.
3. SRKT works well in axial length < 21 mm and > 26 mm.

Other Formulae:

- Holladay I
- Hoffer II
- Binkhorst II

Recent Developments:

- *Holladay –2* formula for IOL Calculation tackles severe myopia by using seven variables rather than two or three .
- **Holladay IOL consultant (HIC) program** uses Holladay 2 formula and performs complex power calculation for the surgeon. It has various other new features, which are beyond the scope of the article.
- Recently the New *Haigis Formula*, has become available, which when optimized for the axial length dependency of the type of IOL to be used, can provide a high degree of accuracy irrespective of axial length or lens type available in commercial software program.

Gaussian Optics Formula: That calculates the power of a lens (in this case the cornea) accounting for the front and back curvatures will ultimately be the preferred technique for post- refractive IOL power calculations. However we have to wait until we have technology that can measure the posterior corneal curvature accurately.

IOL CALCULATIONS AFTER REFRACTIVE SURGERY – A Complex Problem:

- Warn your refractive surgery patients needing Cataract surgery about the reduced accuracy of IOL calculation.
- RK procedures were performed through the 1980s and 1990s. As these patient age, more and more of them are going to require Cataract surgery and the same applies for LASIK patients.
- Several factors affect the accuracy of Keratometry after refractive surgery; as the latter changes corneal asphericity there is an increased range of powers within the central region measured by the Keratometer.
- Theoretically this problem can be overcome by CVK (Computerized Video Keratography), but because both CVK and Keratometry calculate average corneal power using a standardised index of Refraction (SIR) value of 1.3375, they cannot be relied on in Post PRK and Post Lasik eyes since these ablative procedures reduces the SIR.
- Unlike Keratometers and CVK which measure only the anterior corneal surface, the ORBSCAN determines average corneal power, but accuracy of posterior corneal power is less and becomes unpredictable after LASIK treatment.
- IOL power determination in Post RK eyes is a real challenge because there is significant post – operative hyperopia requiring subsequent IOL exchange.

WHICH **'K'** IS OK POST – RK / POST – LASIK :

The methods suggested for doing this in a post RK / Post LASIK eye involves using K values calculated either by:

- Clinical history
- Contact lens over correction
- Topography / computerized video keratography

1. THE CLINICAL HISTORY APPROACH:

It is considered the gold standard. To use this method, surgeons need to have available to them the keratometric or CVK values and the manifest refraction (MR) from before the refractive surgery as well as MR at appropriate intervals after the refractive procedure. The data is used to calculate the change in MR from pre to post refractive surgery and that value is subtracted from the original keratometric value to obtain the "effective Keratometric Value" for use in IOL power calculation.

In this method the post-op MR value that should be used is the most recent one obtained before Cataract development as refraction is effected by the lens change.

For Example, if the patient had a mean prerefractive surgery K of 42 D and refraction of 9.5 D, when you perform a vertex correction from spectacle plane to corneal plane the 9.5 D becomes 8.5 D. If in this case the post-op spherical equivalent is +0.5 D, You have had a 9.0 D change in refraction. Subtracting 9 from 42, the presumed true corneal power at present would be 33D.

2. THE CONTACT LENS OVERREFRACTION METHOD:

This method requires that the patient can be refracted to an accuracy of 20/70 or 20/80. This excludes advanced Cataracts. So this method is good for clear lens extraction.

Refraction determined with a contact lens of known base curve and power is placed on the eye. and the K value, for the use in the IOL calculation is determined by subtracting the current MR from the sum of the over- refraction value, the contact lens base curve and contact lens power. Reliability depends on having a well fitting contact lens.

For Example: A 59-year-old patient had RK done 5 yrs. Back, now for clear lens extraction (Lensectomy) he has no previous records.

His present refraction is +5 D. Now if we over refract with a contact lens of base curve of 36 with a power of –2. If his cornea was actually 36 his contact lens over refraction should be +7 D, in fact it is +6 D. The difference of 1 D means that contact lens must be 1 D steeper than the cornea. Therefore his true 'K' would be 36-1® 35 for IOL

calculation.

3. TOPOGRAPHIC (Computerized videokeratography) CVK METHOD:

This is not very accurate. This is used when Pre-op 'K' is not known in a dense cataract patient. A CVK derived mean anterior corneal curvature value calculated for a specific 3 mm central region of cornea, modified based on the amount of surgically induced refraction change, is used.

But this is not as accurate as other techniques; because ablative procedure changes SIR.

TIPS:

· To choose flattest 'K' by various approaches mentioned above.
· To choose third or fourth generation IOL calculation formula.
· Aim for about –1.5 to 2 D
· This will minimise hyperopic overcorrection in post RK eye's undergoing IOL implantation.
· Still there can be transient hyperopia, wait until the manifest refraction and topography value stabilize.
· If it persists discuss with patient, mention the potential need for lens exchange or Piggyback lens.

RECENT DEVELOPMENT:

1. OPTICAL BIOMETRY : High precision Axial length measurement

Optical biometry based on the use of non-contact partial coherence interferometry (IOL master Zeiss Humphney systems) provides an easier and more predictable way to measure the eye for IOL calculation than older ultrasound techniques, because it measure true axial length along the line of sight since the patient actually fixates on the laser beam.

But optical biometry is unable to provide axial length measurements in those eyes with dense cataracts.

It is a comfortable technique for the patient because it is non- contact, done in sitting position without any topical anesthesia.

This technique is very helpful in Multifocal IOL refractive accuracy to achieve spectacle independence.

2. OKULIX: A new biometric computer program to stimulate whole pseudophakic eye aims to reduce calculation error and ensure a more reliable estimation of IOL strength.

The main difference between this approach and others is that we clearly separate between measuring and calculating errors. We can avoid measuring errors like axial length, corneal power and a good estimation of postoperative IOL position. OKULIX will perform well only with exact measurements.

HOW TO CORRECT REFRACTIVE SURPRISES:

In a recent study in Amsterdam "Incorrect IOL power is the most common reason for secondary IOL implantation and a secondary piggyback lens is the best means of correction."

The first implant must be in the capsular bag in order to have sufficient room for the secondary IOL and the zonules must be intact so as to tolerate manipulation.

POWER CALCULATION IN REFRACTIVE SURPRISES

1. Empirical rule of thumb:

IOL power for a hyperopic error is calculated by multiplying it by 1.5.

Myopic errors are corrected with an IOL power closest to the error.

The ratio of hyperopic power to expected correction is 1.5: 1, while ratio of myopic power to expected correction -1 :-0.85.

2. By Biometry: As a routine procedure.

Few Tips:

· Simple rule of thumb for IOL calculation in aphakic contact lens wearers AC IOL power is approximately equal to contact lens power plus 6 D.
· A decentred or tilted IOL can induce artificial astigmatism that is not due to Corneal curvature, So it is important to distinguish between keratometric and non-keratometric cylinder.

If you steal from one author, it's plagiarism; if you steal from many, it's research.
Wilson Mizner (1876–1933), U.S. dramatist

In the course of writing one historical book or another, it has happened that I could hardly restrain myself from simply copying entire documents. Indeed, I sometimes sank down among the documents and said to myself, I can't improve on these.
Alfred Döblin (1878–1957), German-Jewish novelist, physician.