THE ROYAL COLLEGE OF OPHTHALMOLOGISTS

Focus

Autumn
2010

An occasional update commissioned by the College. The views expressed are those of the author.

Refractive Surprise after Cataract Surgery

Milind Pande, Medical Director
Vision Surgery & Research Centre, Hull.

The last decade has seen the emergence of refractive cataract surgery. This is defined as cataract surgery which not only restores the transparency of the ocular media but also attempts to correct any refractive aberrations of the eye, with the objective of achieving the best possible uncorrected visual acuity. This reduces the spectacle dependence of patients with consequent quality of life and economic benefits. Aspheric Monofocal, Toric, Multifocal and Accommodative IOLs provide good options to achieve reduced spectacle dependence. It is not unreasonable to expect almost all patients free of co-morbidity to achieve uncorrected vision equal to or better than the legal standard to drive a car with aspheric monofocal IOLs. Multifocal and Accommodative IOLs can in addition provide good intermediate and near vision without spectacles.

The success of refractive cataract surgery depends on achieving a predictable refractive outcome for defocus (spherical equivalent) and astigmatism. Refractive surprises can seriously compromise patient satisfaction and also give rise to potential problems of anisometropia, dominance switch in which the dominant eye ends up with the weaker uncorrected vision and, above all, give rise a sense of failure in patients expecting good uncorrected visual acuity. This article focuses on the prevention and management of refractive surprises in cataract surgery.

Prevention: Percival et al[1] using ultrasound measurements and customised lens constants reported 97% of eyes achieving a refractive outcome within 1 dioptre of target. Gale et al[2] suggest a benchmark for NHS cataract surgery is to achieve 85% within 1 dioptre. These figures have to be viewed within the perspective of the normal distribution of refractive error in the population with 66% of eyes within 1 dioptre of emmetropia. It follows that if one is to use a standard power IOL within the population without any biometry, 66% of eyes would fall within 1 dioptre of target. It is interesting to look at the causes of refractive surprise after cataract surgery. In 1992 prior to the advent of optical biometry, Olsen[3] reported that 54% of refractive surprises were due to errors in axial length measurement, 38% were due to errors in predicting the post operative IOL position and 8% were due to errors in keratometry measurements. The advent of optical biometry improved the accuracy and consistency of axial length measurements to such a degree that a similar study by Norrby[4] in 2008 showed that the commonest source of error is in the prediction of post operative IOL position (36%), followed by errors in post operative refraction (27%), axial length measurement (17%), keratometry (10%), pupil size (8%), variation in refraction across the pupil and IOL power 1%. Optical biometry is an essential tool for improving the accuracy of IOL power calculation. In patients with dense cataract where optical biometry is not feasible, immersion ultrasound biometry provides similar levels of accuracy.

There are various protocols available to improve the accuracy of measurements and all of them are based on rechecking the measurements when the probability of these occurring in the population is very low. These protocols are implemented within the newer versions of software for optical biometry machines. Although these protocols alert the operator to unusual measurements they do not identify errors, which do not appear to be unusual in patients with unusual eyes. It is thus critical to not only use these protocols but to supplement them with a strategy of reconciling the IOL power measurements with the patient's refractive history prior to the development of cataracts. A crude rule of thumb is to expect a difference of 3 dioptres in the IOL power between eyes with a difference in pre-cataract refraction of 2 dioptres. Reducing the risk of refractive surprise requires a consistent approach to measuring eyes, reconciling the measurements with the patient's refractive history, using a modern theoretical formula like the SRK-T, Haigis or the Holladay 2 and customising formula constants for surgeons as well as different lenses.

Small hyperopic eyes, large myopic eyes, eyes with very steep or flat corneas, shallow anterior chamber depths, prior history of refractive surgery, vitrectomy, corneal ectasia, peripheral corneal melt syndromes and contact lens use (when measured without an adequate contact lens holiday) are at significant risk of refractive surprises. It is important to warn these patients of the increased risk of refractive surprise as part of the informed consent process and prepare the patients for a second stage enhancement procedure.

Clinical Assessment of Refractive Surprise: A methodical approach is critical in identifying the cause of a refractive surprise. This consists of the following:

1. Refraction: Inaccurate refraction[4] is the second most common cause of refractive surprise after cataract surgery. An accurate subjective refraction is essential. Auto-refractor measurements while repeatable are not consistent with subjective assessments. A repeatable consistent strategy to refract postoperative patients is essential in order to reduce errors as well customise lens constants. The post-operative refraction also forms the basis for calculating the correction needed in a secondary enhancement procedure.
2. Repeat Biometry Measurements: Optical biometry makes it easy to measure the axial length and keratometry in pseudophakic eyes. This will identify any measurement errors in the original biometry.
3. Calculating IOL power with the new measurements allows for a comparison with the previous calculation. The difference in IOL power between the original and recalculation should be consistent with the magnitude of the refractive surprise. If the full magnitude of the refractive surprise cannot be explained by the difference between the original and recalculated IOL power other factors apart from measurement error like prediction of postoperative IOL position or a lens power error may be significant contributors to the refractive surprise. The cause of a refractive surprise can influence the method chosen to correct the refractive surprise.

An example case workup is shown in the box below.

Illustrative Case Workup

75 year Male had R eye Phacoemulsification with a 21D Monofocal IOL with a Plano refractive target. Post Operative refraction achieved was -5 /-0.75 D axis 95. The preoperative measurements and analysis are given below

eye	R eye	L eye	
Ref	-3.5/-1.5 x 85	-1.5	**Analysis:** The IOL power difference between eyes is 0.5D, which is equivalent to a refraction difference of 0.625 D. However the actual difference in refraction between the eyes is 2.75D. One would expect an IOL power difference of 4 D with this refraction difference. The measurements are thus inconsistent with the pre-op refraction status.
K's	44.5/45 @ 176	44/44.5 @ 170	
AvgK	44.75	44.25	
Axl	23.06	23.40	
IOL Power d for emmetropia	21 d	20.5	

The patient was re-measured and the results are below

R eye Measurements	Original	Re-measured	
Ref	-3.5/-1.5 x 85	-5/+0.5 x 95	**Analysis:** The re-measured IOL power is 7 dioptres less than the originally measured IOL power. This translates to a spectacle refraction difference of -4.86 dioptres almost the entire refractive surprise. This value is determined by looking
K's	44.5/45 @ 176	44.5/45.49 @ 170	

Correction of Refractive Surprise: Identifying the cause of a refractive surprise is critical in picking the correct refractive enhancement procedure to correct the surprise. Not all surprises need to be corrected. Prior to any such enhancement it is important to identify and demonstrate the benefits as well as the potential risks a patient may expect from an enhancement procedure. It is important to keep in mind the trade-offs a patient may have to accept by carrying out an enhancement procedure. Patients who end up myopic in their non-dominant eye may well prefer the accidental monovision. Similarly patients with multifocal lenses may well prefer a longer working distance attained by a small hyperopic surprise.

Laser vision correction, Secondary Piggyback IOLs and IOL Exchange are the common methods for correcting refractive surprises. It is important to demonstrate a stable refraction before attempting a correction.

Laser vision correction using either LASIK or LASEK will give the most predictable refractive outcome. A completely new type of procedure with considerable cost can create significant anxiety especially in elderly cataract patients.

Secondary Piggyback IOLs placed in the ciliary sulcus is a simple procedure within the comfort zone of most cataract surgeons. The trauma and risks of removing an IOL is avoided and piggybacking covers for an IOL power error. Spherical errors are relatively easy to correct but sphero-cylindrical errors can also be treated with Toric piggyback lenses. The calculations for choosing the power of these lenses is based on the refraction using a vertexing formula like the Refractive Vergence formula[5].

IOL Exchange: This is a method of last resort when all other corrective options have been considered and discarded. Removing an IOL from an eye can be a technical challenge depending on the lens design and the time period the lens has been in the eye. Removing lenses months or years after primary surgery can be fraught with the danger of rupturing the capsule. The replacement IOL calculations use the same method as used for the primary IOL. IOL exchange is not a good method to correct refractive surprise due to an error in predicting the postoperative IOL position or an error in the actual IOL power.

Summary: Refractive surprises after cataract surgery are a common cause of patient dissatisfaction. Prevention requires a consistent method of biometry. A methodical assessment with repeat measurement is needed to identify the cause. A risk benefit assessment is critical to establish the need for a refractive enhancement. Laser vision correction and secondary piggyback IOLs carry lower risk and are more predictable methods for correcting refractive surprises.

References:

1. Percival SP, Vyas AV, Setty SS, Manvikar S. The influence of implant design on accuracy of postoperative refraction. Eye 2002; 16(3): 309–315.
2. Gale RP, Saldana M, Johnston RL, Zuberbuhler B, McKibbin M. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye 2009 23, 149–152
3. Olsen T. Sources of error in intraocular lens power calculation. J Cataract Refract Surg. 1992 Mar;18(2):125-9.
4. Norrby S. Sources of error in intraocular lens power calculation. J Cataract Refract Surg. 2008 Mar;34(3):368-76.
5. Holladay JT: Refractive Power Calculations for Intraocular Lenses in the Phakic Eye. AJO 1993; 116: 63-66