

# Tackling refractive surprise post cataract surgery – A surgeon's nightmare

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## Abstract

Cataract surgery is the most common surgery performed by ophthalmologists. The goal of surgery has shifted from restoring vision to providing a spectacle free vision. Refractive surprise post cataract surgery is one of the most frustrating event. In this article, we describe the measures to deal with refractive surprise post cataract surgery. The choice of treatment varies from non invasive modalities like spectacles to invasive procedures like IOL exchange, Laser vision correction etc.

**Key Words:** Refractive surprise post cataract surgery, unplanned bioptics.

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Received Date: 26/07/2017 Revised Date: 20/08/2017 Accepted Date: 18/09/2017

DOI: <https://doi.org/10.26611/1009339>

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Accessed Date:  
21 September 2017

**Table 1:**

### Causes of refractive surprise

Preoperative	Operative	Postoperative
Errors in Biometry – keratometry, Axial length, Aconstant value of IOL	Surgically induced astigmatism	Anterior movement of lens – capsular phimosis, capsular bag contraction
Improper IOL selection	Mis alignment of toric IOL	Lens tilt
Inappropriate IOL power formula(in extreme ametropic eyes)	Inverted Upside down implantation of IOL	Posterior capsular opacification
Uncorrected & overlooked pre op corneal astigmatism		

## INTRODUCTION

Cataract Surgery is the most common surgery performed by Ophthalmologists worldwide. It has evolved from Intra Capsular Cataract Extraction (ICCE) to the newest Key hole Phacoemulsification Surgery (MICS). The expectations from the patients have also shifted drastically leading to narrowing the margin of error. While in olden days Cataract Surgery was to mainly provide vision, the expectations of patients shifted to have a spectacle free distance and near vision which may also be because of the promises we make to the Patients. In such a situation having a refractive surprise is frustrating for both Surgeon and the Patient. Whenever we have a refractive surprise it is important to retrospect and to find the source of error so that such instances are not repeated.

**Causes of refractive surprise:** Some of the reasons which have to be looked into after having a refractive surprise can be categorized into pre operative, operative and post operative causes. Refractive Surprises are more common in situations where the gold standard for calculating the intra ocular lens power has not been standardized yet like in cases of post RK Cataract Surgery, Post Refractive Cataract Surgery, Post Keratoplasty Cataract Surgery, in high myopic, high hyperopic eyes, cataract in patient with keratoconus. It is important to double check the accuracy of keratometry, axial length, Intra Ocular Lens(IOL) power selection and the type of formulae which are used to calculate the IOL

Power in very small and very large eyes. Preoperative corneal astigmatism is also one of the important but overlooked factor which can lead to Post operative Refractive Surprise. Operative factors which can lead to refractive surprise include surgically induced astigmatism, placing an IOL calculated for in the bag implantation in the Sulcus, misalignment of toric intra ocular lenses, inverted upside down implantation of Intra Ocular Lens. Capsular bag contraction and phimosis, decentration, lens tilt, posterior capsular opacification are some of the causes of Post operative refractive surprise. Refractive surprise may manifest as myopia, hyperopia, or astigmatism.

**Treatment of refractive surprise:** The treatment of refractive surprise will depends upon the refractive needs of the patient, it may vary from non invasive treatment like spectacle correction to the more complex surgical correction. Spectacles and Contact Lenses are the non invasive modalities which can be tried for minimal errors and in patients who are ready to use the same. The invasive surgical procedures are used in patients who are having high degrees of error and who are reluctant to use spectacles or contact lenses after the surgery. The surgical procedures have to be planned based on the type of error, magnitude of error, and duration of presentation of the patient after cataract surgery. Before resorting to any surgical intervention it is ideal to have analysed the source of error. The procedures which are done to treat the refractive surprise can be classified based on the timing of the procedure into early and late. Procedures done in the early post operative period include

1. Aligning a misaligned toric IOL
2. Intra Ocular Lens Exchange

Procedures which are done in the late post operative period can be classified as Cornea based procedures and lens based procedures. Cornea based procedures include Astigmatic keratotomy, Limbal relaxing incisions and Laser corneal surgery – LASIK, PRK Intraocular lens based procedures include Piggy back lens implantation, ICL implantation, and Light adjustable IOL implantation

### **MATERIAL AND METHODS**

**Cornea based procedures:** Laser vision correction (LASIK, PRK) Laser vision corrective procedure [LASIK, PRK] are often used to treat residual refractive errors post cataract surgery. Un planned bioptics is the term given to such procedures. Myopia, Hyperopia and Astigmatism can be treated through these modalities. In patients who have already undergone Nd: YAG capsulotomy laser vision correction is a viable option. LASIK is how ever better avoided in patients with thin cornea, irregular astigmatism, and dry eye. When LASIK is planned it is recommended to wait for 3 months for the stabilization of refraction and also to attain stability of the incision. In Patients requesting for earlier correction PRK is

preferred. LASIK and PRK are predictable, safe and accurate which make them the first choice for treating the refractive surprises in most of the patients, however LASIK is found to be in accurate in treating refractive surprises of patients with multifocal lenses. To increase the accuracy in correcting the hyperopic refractive surprise it is advisable to resort to subjective refraction and retinoscopy instead of relying on automated refractometers. It has been found that Automated refractometers generally underestimate the spherical power. Epithelial in growth, diffuse lamellar keratitis, post operative dry eye are possible complications with LASIK

**Astigmatic Keratotomy/Limbal relaxing incisions:** With the advent of femtosecond lasers astigmatic keratotomy and limbal relaxing incisions have gained popularity in treating regular astigmatism in the range of 0.75 to 2.75D. In the absence of availability of femtosecond lasers guarded blades, diamond blades have been used to perform the same. There are several nomograms which guide as to the length and the site of incision to be made, however the efficacy of treatment may be modulated because of the wound healing of cornea which makes it less predictable than laser vision corrective procedures. In patients with dry eye, connective tissue disorders chronic diabetes these procedures are avoided because of problems with delayed wound healing.

**Lens based Procedures:** These procedures are useful in correcting high degrees of ametropia.

**Toric IOL misalignment:** For every degree of misalignment of the toric intraocular lens 3% of the lens power is lost. If the misalignment is more than 30 degrees then it causes significant induced astigmatism post operatively. The manifest refraction in the post operative period gives a clue to the cause of refractive surprise .If the refractive surprise is due to an misalignment the spherical equivalent of the manifest refraction is zero like  $-1DSph/+2Dcyl @80$  degrees. Its advisable to take up the patient early within 1 to 3 weeks for reliagment to prevent adhesions forming between the lens and the capsular bag. Sites such as astigmatismfix.com have formula designed by John Berdahl and David Hardten, which give you the amount of rotation which needs to be performed based on the manifest refraction of the patient. Other things which need to be taken care of are prevention of overfilling of eye, complete viscoelastic removal at the end of surgery.

**Intraocular lens exchange:** When the cause of large refractive surprise has been found to be because of implantation of IOL of wrong power intraocular lens exchange is an option which has to be considered in the immediate post operative period. Delay in this procedure

is preferably avoided since formation of capsulolenticular adhesions would complicate the procedure further. Having a through documentation of the pre operative investigations like A scan biometry, Keratometry, axial length measurements, IOL power formula used and the power of implanted IOL will help in recognizing the culprit. It is advisable to also double check for the orientation and power of the intraocular lens in the operation theater before surgery and during implantation to avoid such mishaps. Use of Correct IOL formulae is also of utmost important to avoid post operative surprises. In patients with axial length less than 22mm it is advisable to use Hoffer Q/ Holladay II formulae. In patients with axial length ranging from 22 to 24.5 mm it is advisable to use Holladay I/ Hoffer Q. In patients with axial length between 24.5 to 26 mm it is advisable to use Holladay I and in patients with axial length above 26mm it is recommended to use SRK-T/ Holladay II formulae. It is also important to check for the A Constant of the IOL implanted. The biometry for the lens exchange can be done in the pseudophakic mode. Among the various techniques described in the literature for lens exchange the incision size varied from 2.75 mm to 4mm. Partial transection of the lens with a hinge technique, full transection, IOL bisection, optic quadrantotomy, intraocular refolding of the IOL, IOL bisection, partial optic bisection, IOL removal through a 4.0 mm scleral frown incision, transection of the IOL haptics with the Neodymium: YAG laser and crisscross lensotomy for

silicone plate-haptic IOLs have been described. It is eadier to explant Hydrophilic lenses due to lesser sticky ness with the capsule. There is always a risk of Posterior capsular rupture, zonulo dialysis with vitreous loss, corneal endothelial loss, CME, endophthalmitis, when the patient is taken up for the second procedure.

**RESULTS**

**Piggy back lens implantation:** Piggy back lenses were used in high hyperopes to provide the exact intraocular power. These lenses are a viable option in correcting the refractive surprise after cataract surgery. Other favourable prerequisite factors are patients with a stable PCIOL in the bag, deep or normal anterior chamber, and normal corneal endothelium. Patients with post RK cataract with a refractive surprise are good candidates as in these patients it is prudent to wait for the refractive error to stabilise thus making it a preferred option over IOL exchange. Calculation of refractive power of the piggy back IOL depends on the post op manifest residual refraction. (Spherical equivalent), A constant of the piggyback IOL. Various nomograms have been suggested for calculating the power of piggy back IOL. Refractive vergence formula and Holladay IOL software using Holladay R formula provide accurate power specially when there is higher amount of refractive surprise. Gill’s nomogram is another simple way of calculating the piggy back IOL lens power based on spherical equivalent.

**Table 1:**

Procedure	Indications	Advantages	Limitations
LASIK	Myopic, hyperopic, astigmatic surprise	Safe ,effective, predictable	Wait for 3 months for cataract wound stability Excacerbation of dry eye Induction of higher order aberrations Not suitable in thin corneas Longer healing time
PRK	Myopic ,hyperopic, astigmatic surprise Large refractive surprises(spherical errors)	Safe ,effective, Predictable Can be done in immediate post op period	Technically difficult once capsule lenticular adhesions develop Greater chances of vitreous loss ,zonulodialysis
IOL exchange	Large refractive surprises	Best done in immediate post op period Can be done early post op also Easy to calculate the IOL power needed Technically easier Reversible	Interlenticular opacification, Uveitis Glaucoma

**Table 2: Gill’s nomogram**

Under powered Pseudophake (hyperope)	Piggy back IOL power(P)
1.Short eye <21mm	$P = ( 1.5 \times SE) +1$
2.Average eye 22-26mm	$P = (1.4 \times SE) + 1$
3. Long eye >27mm	$P = (1.3 \times SE) +1$

**Table 3:**

Over Powered Pseudophake (Myope)	Piggy back IOL power (P)
1.Short eye <21mm	$P = ( 1.5 \times SE) - 1$
2.Average eye 22-26mm	$P = (1.4 \times SE) - 1$
3. Long eye >27mm	$P = (1.3 \times SE) - 1$

Other nomograms which are available include Nichamin Nomogram for AQ5010V model of sulcus IOL. In this for minus power, the piggy back IOL lens power is taken in the ratio of 1:1. Example for minus 4SE error a -4D IOL power is chosen. For a plus residual refractive error, the ratio is 1:1.5. Example for 3D SE error +4.5D IOL power is chosen. Brown's refractive reasoning is another nomogram in which 0.37D power at spectacle plane equates to 0.5D IOL power. IOL which are available for piggyback IOL implantation are AMO Sensar is available in the range of -10 to +30 D in half dioptre steps. It is a 3 piece acrylic lens with 6mm optic and 13mm length. STAAR AQ 2010 & AQ5010 – Silicone IOL with 6.3mm optic (larger optic zone = lesser chances of iris capture) AQ2010 is 13.5mm in length and is available in +5 to +9D in whole dioptre steps and +9.5 to +30D in half dioptre steps. AQ5010 is 14mm in length and is available in the range of - 4 to +4 in whole dioptre steps. However these lenses are not available in India as of now. Sulcoflex (Rayner) – This lens is not yet FDA approved. It is a hydrophilic acrylic lens with 6.5mm aspheric optic and 13.5mm in length for implantation into the sulcus. It has a posterior concave surface which avoids contact between the two lenses. It has undulating haptics with posterior 10 degrees angulation to reduce the risk of pigment dispersion syndrome and increase rotational stability. Toric and multifocal platforms are also available in this lens in the sulcoflex design. Technique of implantation is similar to lens implantation in sulcus. It is important to note that these lenses may be associated with complications like iris chaffing, pigment dispersion glaucoma, uveitis, inter lenticular opacification. Inter lenticular opacification or red rock syndrome is the term used for the development of Elschnig pearls in between the IOL after piggy back lens implantation. It results in loss of best corrected visual acuity and a hyperopic shift. It is more common when the two lenses are placed in the bag. If a piggy back lens is planned in the bag presence of larger optic lens and larger capsulorrhexis is advised. To reduce the chances of interlenticular opacification it is suggested to place the piggy back IOL in the sulcus.

**ICL following cataract:** STAAR ICL is another option to correct myopic refractive surprise. Its thinness, flexibility, vaulting decrease the chance of inter lenticular opacification. The procedure and technique of power calculation is similar to phakic IOL, however it is not yet available in India.

**Light adjusted IOL:** In cases where refractive surprise is expected a new IOL is being tried, which is the Light adjusted IOL, it is a 3 piece photo reactive silicone lens with square edge haptics. It is still unavailable in India. In this the post operative refractive surprise is treated by irradiating the optic surface using a special device. It is

useful to treat upto 2D of myopia, hyperopia and astigmatism.

**Laser based procedures Vs Lens based procedures:** A study conducted by Jin et al, compared the efficacy of LASIK and lens based procedures and concluded that both have advantages in different settings. LASIK proved to be effective in reducing the lens power when performed 3 months after primary cataract surgery with no untoward complications. LASIK fared better over IOL related procedures in patients with simple astigmatism, mixed astigmatism, low degrees of myopia and hyperopia. LASIK and PRK offered greater flexibility and allow more specific target end point than lens based procedures. Lens based procedures are preferred when it is desired to correct the power in the immediate post operative period. They are more effective in patients who have large spherical powers to be corrected. Another advantage is that as the corneal refractive power is not altered it can be conveniently done in patients with low corneal thickness and there is no effect of additional aberrations due to altered corneal surface as in corneal procedures. These procedures can be done by opening up the primary wound and logistically would be feasible in set ups where there is no refractive suite associated. However lens based procedures are associated with disadvantages as being technically difficult (IOL exchange) with greater risk of intra ocular complications like increased endothelial loss, risk of vitreous loss and posterior capsular rupture intra operatively.

## CONCLUSION

It is important that before these procedures are done thorough review of the case and clinical examination to pin point the exact cause of error and treating issues like primary posterior capsular opacification, anterior shifting of lens due to capsular phimosis. misalignment of a toric IOL should be looked into. There has been an increasing trend towards laser vision correction for the post operative refractive surprise due to greater flexibility and predictability in post operative outcomes. However the decision of either procedure is best done on case to case basis rather than a generalised format.

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Source of Support: None Declared  
Conflict of Interest: None Declared

