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An occasional update commissioned by the College.
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Managing refractive surprise

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Cataract surgery is increasingly a refractive procedure that aims to reduce spectacle dependence and the majority of patients with no ocular comorbidity achieve unaided driving vision (6/12 in the UK).[1] A refractive surprise is the failure to achieve the intended post-operative refractive target. It can cause anisometropia or dominance switch and is a source of patient dissatisfaction due to unmet expectations.

Preventing refractive surprise

The best way to manage refractive surprise is to prevent it. The 2017 NICE guidelines on the management of cataracts provide advice on prevention of refractive surprise through accurate biometry, A-constant optimisation, intraocular lens (IOL) formula selection and avoiding wrong lens implant errors.[2] Benchmark standards for NHS cataract surgery dictate that 85% of eyes should be within 1D and 55% within 0.5D of target spherical equivalent refraction following surgery.[3]

Measuring the eye

Partial coherence interferometry (PCI) is the most common way to determine axial length. This is better than ultrasound A-scan as it has greater precision, is not affected by velocity estimates (e.g. in silicone oil-filled eyes) and measures along the visual axis. In eyes with dense cataract, PCI may not be possible and A-scan becomes necessary.[4] Cross-checking this with B-scan helps identify the presence of posterior staphyloma.

Keratometry is a frequent source of biometry errors. Contact lenses wearers should not wear them before biometry (typically 1 week for soft lenses and 2 weeks for rigid gas-permeables). Patients with prior corneal refractive surgery, keratoconus, corneal scarring or corneal graft require additional corneal topography. Different IOL formulae are required for prior myopia or hyperopia (e.g. Haigis-L).

IOL Formulae

Most modern formulae are good at predicting post-operative refraction in standard eyes (axial length of 22-26mm), with the NICE guidelines recommending Barrett Universal II or SRK/T. In short and long eyes there is greater variability primarily due to the post-operative effective lens position (ELP). The NICE guidelines recommend using Haigis or Hoffer Q if the axial length is less than 22mm and the Haigis or SRK/T if the axial length is greater than 26mm. OKULIX ray-tracing software and the Hill-RBH calculator also show promise in improving biometric calculations. A-constant optimisation further improves post-operative refraction prediction and is readily available via the website of the User Group for Laser Interference Biometry (ULIB).[5]

Repeating biometry

Consideration should be given to repeating biometry when findings differ significantly from the population mean. The NICE guidelines do not stipulate when biometry should be repeated but the 2010 College guidelines recommended this should be done for:

- Axial length under 21.2mm or over 26.6mm
- Mean keratometry under 41D or over 47D
- Corneal astigmatism over 2.5D
- Difference in axial length between fellow eyes over 0.7mm
- Difference in mean keratometry between fellow eyes over 0.9D

Avoiding wrong IOL implantation

Preventing wrong IOL implantation requires compliance with standard operating procedures (SOPs) and the WHO Surgical Safety Checklist modified to include cataract surgery checks.[6] Most cases of insertion of an incorrect IOL are due to human error and failure to adhere to SOP.

Refractive reconciliation

Common sense is essential in IOL selection. The biometry should be consistent with the refractive history. As a rule of thumb, a 3D difference in the IOL power equates to a 2D change in the refraction.

Identifying the cause of refractive surprise

1. A formal subjective refraction is essential as auto-refraction is prone to error.
2. A thorough dilated examination is necessary to identify surgical causes such as tight corneal sutures , placement of the IOL in the sulcus or subluxation. Look for a distended capsular bag due to retained viscoelastic that can cause a myopic shift. The presence of corneal pathology such as corneal scarring or oedema can influence the refractive outcome. Post-operative cystoid macular oedema can cause a hyperopic shift.
3. Review the refractive history as well as the biometry, the IOL selection process and the surgical records. Wrong patient biometry, transcription errors, selecting the lens from the ACIOL column, incorrect A-constant or incorrect formula can all lead to insertion of the wrong IOL.[6]
4. Check the axial length by repeating the biometry. PCI may not have been possible prior to surgery due to a dense cataract. Ultrasound measurements are prone to error as contact with the cornea may compress the eye and lead to underestimation of axial length.
5. Check for abnormal keratometry. The presence of high Ks or astigmatism can indicate pre-existing undiagnosed keratoconus. Previous refractive surgery is not always volunteered by the patient. LASIK flaps can be hard to detect and absent in previous LASEK/PRK.
6. If there has been no error, the refractive surprise can be attributed to effective lens position and a similar error is likely to occur in the fellow eye.

Clinical management of refractive surprise

If IOL selection error is detected, report it using the hospital incident reporting system. This is essential to learn from mistakes and avoid repetition. Explain the error openly and offer an apology. This is essential to comply with the statutory duty of candour. This is not a declaration of guilt but an acknowledgment that you have not achieved the desired target refraction. Offer a second opinion. This in itself can help diffuse a confrontational situation and allow meaningful dialogue to take place.

The error needs to be graded within days to determine the level of severity, whether a formal root cause analysis is required and whether the incident is a NEVER event.[7]

Doing nothing is always an option

Many refractive surprises do not require further surgery. Low myopia may give useful monovision and the ability to read unaided. A patient who has worn glasses all their life may be willing to continue wearing them, and some patients do not mind wearing contact lenses. Time spent speaking candidly to the patient is time well-spent and helps prevent dissatisfaction later. The benefits and risks of further intervention should be explained.

Retained viscoelastic

Early laser capsulotomy can disperse the viscoelastic and allow the anteriorly displaced IOL to move posteriorly.

Corneal refractive surgery

Laser refractive surgery (PRK or LASIK) is a good option after refractive surprise. It can treat a large range of refractive error including astigmatism although care should be taken with pre-existing ocular surface disease such as dry eye. It should only be performed once the refraction is stable, typically after 3 months. This additional time allows some patients to become accustomed to their new prescription and they may decline further intervention. Cost and access may be prohibitive.

IOL exchange

IOL exchange is possible and ideally undertaken soon after the initial surgery before capsular fibrosis has occurred. IOL exchange, however, carries the risk of capsular damage and vitreous loss.

Piggyback sulcus IOL

A sulcus IOL inserted as an additional (piggyback) lens to the original IOL is another option. As this corrects the manifest refractive error, the power of the original IOL does not need to be known. Piggyback lenses are less accurate than laser refractive surgery but good for higher degrees of refractive error and avoid the risks of IOL exchange as well as those with ocular surface disease where laser is not suitable.

Conclusions

Advances in biometry as well as adherence to SOP mean that refractive surprises are thankfully becoming less common. As with all surgical complications, the best way of managing refractive surprise is to prevent it in the first place. This requires a systems approach to reduce human error. When refractive surprises do occur, be open with patients and discuss the options for effectively managing the refractive error.

Case example:

A 66-year-old female underwent bilateral sequential cataract surgery aiming for emmetropia. She had a history of bilateral LASIK in India 15 years earlier but no access to her refractive history. After cataract surgery, the patient was found to be -3D myopic in both eyes. A review of her biometry shows the Haigis L-MYOPIC formula was used for IOL power calculation instead of the correct Haigis L-HYPEROPIC formula. Her original hyperopia was predictable from her short axial length, steep keratometry and age of LASIK (refractive surgery in late 40s/50s/60s performed when reading glasses become heavier). The patient was happy with her new ability to read unaided and decided against further surgery.

Biometry in previous refractive surgery

- Patient to provide pre-refractive surgery data where possible
- Helpful clues:

	Average eye	Myopic treatment	Hyperopic treatment
Axial length (mm)	22.5 – 24.5	Long eye	Short eye
Keratometry (D)	43.27	Flat K readings	Steep K readings
Age at time of refractive surgery		20s & 30s	Late 40s, 50s & 60s

Biometry in keratoconus[8]

- Biometry in keratoconus typically overestimates corneal power and leads to hyperopic surprise
- **Recommendations**

K ≤ 55D (mild/moderate)

- Use actual K values; target –1 D (K ≤ 48); -1.5 D (48 - 55 D)
- Toric IOLs *only* if spectacle corrected pre-op

K > 55D (severe)

- Use standard K values 43.25 D; target -2 D (more if scleral lens wearer)
- No toric IOLs in RGP/scleral lens wearers

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