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South Asia Edition

Nurses being briefed before a cataract operation. INDIA
ARAVIND EYE CARE SYSTEMS

Cataract surgery in patients with complex conditions

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Cataract surgery is not always straightforward, but with careful planning by the surgical team, patients with complex conditions can still have a successful outcome.

Every ophthalmologist encounters patients with challenging or complicated cataract presentation from time to time, which tests our surgical skills and ability to manage difficult circumstances. The challenge may come from zonular weakness; cataract in very young patients; cataract with corneal opacities; cataract with co-morbidities, such as uveitis, glaucoma, diabetic eye disease or age-related macular degeneration; or intraoperative complications, such as posterior capsule tears and zonule or iris dialyses.

As surgeons, we must rely on our surgical skills, intelligent decision making, and the numerous new technologies that have revolutionised our ability to not just complete the operation, but achieve the best outcome possible.

When I encounter a challenging case, I rely on the following generic guiding principles, which I have learnt from my mentors and from experience, on how best to optimise surgical outcomes in these patients.

- Know your own surgical limitations and refer to a more experienced surgeon when necessary.
- Be vigilant: recognise and anticipate challenges before surgery and ensure you have the correct tools in the operating theatre to help manage any issues that arise.
- Manage the basics to reduce the challenges you are facing. Dilate the pupil as widely as possible, use the appropriate anaesthetic technique, stain the capsule for more predictable capsulorrhexis, choose the

Continues overleaf ➤

About this issue

Cataract is still the leading cause of blindness worldwide. The majority of cataracts are relatively straightforward to remove, but there is a substantial group of patients in whom cataract surgery will be more challenging. Whether this is due to factors related to the patient, such as diabetes or a systemic inflammatory condition; or factors related to the eye itself, such as corneal endothelial dystrophy, glaucoma or a small pupil; preparation of the surgeon, the equipment and the eye team will ensure that patients receive the best possible visual outcomes.

Contents

right viscoelastic for difficult steps and use reliable instruments and microscopes.
- Develop skills using a range of techniques and technologies because every eye is different. For example, the use of capsular support systems, scleral fixation techniques, small pupil management techniques and vitreous management and optic capture techniques in paediatric cataract.
- Have a plan, and have a back-up plan. This helps the surgeon to stay calm, which keeps the patient calm. For example, anticipate poor pupil dilation in uveitic eyes or weak zonules in pseudoexfoliation, and plan for the worst.
- Manage inflammation and complications such as macular oedema as well as you can before and during surgery. This is important in patients with uveitis and diabetes, as well as those with ocular surface disease.
- Use the appropriate technology, or a combination of techniques, for each challenging case to improve surgical effectiveness and efficiency. Ask yourself the following questions: will there really be any added benefit in using a toric or multifocal IOL in this case? Would a combined cataract-glaucoma procedure produce better outcomes for this patient? Should I give an anti-VEGF injection at the time of surgery? Other techniques that help improve outcomes include scraping off the corneal epithelium to increase visibility when appropriate, and the use of adrenergic agents in eyes with floppy irises.
- Follow the correct postoperative regimen for challenging cases in order to improve outcomes. This may include good refractive management, long-term steroids after surgery for uveitic patients, or the use of non-steroidal anti-inflammatory drugs to prevent worsening macular oedema in patients with diabetes.

In conclusion, prepare yourself, your team and your patient for difficult cataract surgery. Always communicate known and expected challenges to the patient before surgery so that you set realistic expectations about the outcome. Discussing the appropriate postoperative care, especially where it is different from routine care, will then be easier.

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Complicated cataract surgery: strong leadership protects patients

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It is said that "safety is no accident." This means that safe medical practice does not happen by chance. Careful planning of your operating environment will protect patients, but it requires a holistic approach as surgeons are only as good as the environment they work in and the team that supports them.

Stock take and procurement

A well-led team will be doing regular stock takes: identifying when stocks are running low and ordering more supplies before the shelf is empty. This is essential if a complication arises and an alternative IOL is needed or a piece of equipment is urgently required (such as an automated vitrector, iris hooks or a certain suture).

Sterilisation schedules

Standard surgical instruments may be arranged in trays appropriate to the operation being performed. When an additional or unexpected instrument is needed, can it be provided at very short notice? This might require single wrapped items to be held in store, or a tray of additional possible instruments to be sterilised at the start of the theatre list and accessed as needed. Whatever the system, it requires good leadership to ensure it is set up in order to make the surgeon's life as easy as possible when the situation is complex.

Clinical pathways to success

Much has been written about how checklists and protocols reduce human error and protect patients. For example, the protocol at the start of the surgical day could include discussing patients on the theatre list with potentially difficult cataract operations and then verifying that the equipment is ready and the full operating team is prepared and appropriately trained in any procedures that may be needed.

If you are in a team where other people put patients on the operating list for you, you may only see the patient on the day of surgery. Consider creating a checklist to guide the history taking and eye examination, both of which are essential in order to identify cataract patients with other pre-existing conditions.

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Regular stock-taking is good practice. INDIA

A history checklist might include:

- Any history of serious ocular trauma
- Previous eye surgery or laser
- Diabetic status

The examination checklist could include:

- Endothelial guttae
- Pseudoexfoliation
- Extent of dilation
- Eye pressure

Teaching trainees to handle complicated surgery

If you are involved in teaching other surgeons, complicated cases provide excellent opportunities for training. Trainees can be involved in pre-operative planning and discussion of strategies. The next time they encounter the same scenario, they may no longer be a trainee.

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Making the most of cataract surgery in patients with diabetes

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Cataract surgery can influence the progression of diabetic eye disease, but may be necessary for treatment and to help the person function effectively. Here is how to make the most of it.

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Operating on a cataract patient. INDIA

Diabetes mellitus is a disease of elevated blood sugar due to insufficient *production* (type 1) or *action* (type 2) of insulin. Type 1 diabetes requires insulin injections, whereas type 2 is managed with diet, exercise, tablets or insulin injections, if needed.

The impact of cataract is twofold:

1 Poor view of the retina means that laser and intravitreal injections to treat the visual complications of diabetes, such as diabetic retinopathy or maculopathy, might become impossible. Without treatment, these can progress to the point where potential vision is so poor that cataract removal will not lead to visual improvement.
2 Failing sight, due to cataract, cause practical difficulties with the timely administration of medication to control blood glucose (blood sugar). This is especially true for those who have to inject insulin.

Unfortunately, cataract tends to have an early onset in those with diabetes and progresses rapidly if blood sugar control is suboptimal. This is most likely due to the osmotic changes taking place within the lens, usually resulting in cortical or posterior subcapsular lens opacities.

Identifying patients with diabetes

In low- and middle-income countries, the first time many people are recognised as having diabetes is when they come to an eye clinic for cataract surgery. It is therefore vital to take a careful history, conduct a thorough eye examination and measure blood glucose before surgery to identify those who may have diabetes.

People who are young and have both diabetes and cataract may have neglected their blood sugar control over the years or may not have had access to facilities to enable them to achieve good control. If blood sugar is not controlled, it will be very difficult to prevent vision loss to diabetic retinopathy.

Referral

Cataract patients with diabetes must be referred to an endocrinologist or suitably qualified physician so their diabetes can be managed.

Ensure that the endocrinologist or physician knows where to refer people with diabetes for regular retinal examinations, during which an eye care professional will check for signs of diabetic eye disease (diabetic retinopathy and diabetic maculopathy).

The risks of cataract surgery

There is a potential risk that diabetic eye disease may progress as a direct result of cataract surgery. This depends on:

- The level of retinopathy and maculopathy at the time of surgery
- Whether surgery was complicated or uncomplicated
- Blood sugar control.

All these factors have an impact on the progression of retinopathy. Squirrell et al[1] noted that much of the progression of retinopathy in their cohort was due to natural history and that uncomplicated cataract surgery using phacoemulsification is not an

independent factor for accelerated progression of retinopathy after surgery. **Editor's note:** the study did not compare phacoemulsification with small-incision cataract surgery.

Zaczek et al[2] and the UK EMR observational study[3] found that eyes with pre-existing macular oedema had the worst prognosis for visual rehabilitation. If the fundus is visible prior to surgery and there is diabetic retinopathy and/or maculopathy, it is worth following the treatment guidelines in Table 1 prior to cataract surgery in order to prevent worsening of the diabetic retinopathy.

Communicating with patients

It is important to manage the expectations of cataract patients who also have diabetes, as potential visual loss due to diabetic eye disease may affect the amount of visual improvement possible after surgery.

Talking with patients about all the risks and benefits of treatment is an important part of the process, both preoperatively and postoperatively, as it helps both parties to clearly understand the potential visual outcomes of the operation. Discuss the potential need for postoperative interventions, such as laser treatment and/or anti-VEGF injections, before taking consent. It is important to ensure that the patient is willing, and able, to come back to the clinic for these treatments.

In patients with more advanced disease, ask what treatment they have undergone; e.g., laser treatment, anti-VEGF injections, or intravitreal steroids; this can also affect outcomes.

From a medico-legal perspective, it is important to document all of the above information carefully.

You can improve patients' experience by giving clear instructions about how to care for their eye after surgery and when to come back. Put in place specific, identifiable personnel as a point of contact for patients. This will minimise the loss of patients at postoperative and subsequent follow-up visits.

Blood sugar control

There have always been questions about optimum blood sugar control for patients with diabetes prior to cataract surgery. However, there is no published evidence to suggest that elevated blood glucose level at the time of surgery has a negative effect on outcome,[4] and the risk of cancelling a patient (who may not return) may outweigh the benefits – if any exist – of deferring surgery until they control their blood sugar better.

It is not unreasonable however, to take steps to reduce blood sugar (e.g. giving an additional insulin injection if they have Type 1 diabetes) on the day of surgery if patients present with very high levels.[5]

Intraoperative considerations

Cataract surgery in patients with diabetes can be complicated as a direct result of their diabetes. There may be poor pupil dilation due to lack of tone in the iris muscles, secondary to autonomic neuropathy; this is often seen in patients with chronic diabetes. If there is poor dilation, or in patients with intraoperative miosis, it is necessary to manually dilate the pupil, whether by using pupil hooks/dilators or by performing an iridectomy (see pp. 84–85).

In younger people with diabetes and cataract, extra care must be taken as their capsule tends to be elastic, leading to complications such as capsular tears. Use trypan blue ophthalmic solution to stain the anterior lens capsule.

Postoperative inflammation is expected to be worse in patients with diabetes. This can lead to contraction of the anterior capsule and phimosis, which in turn limits the view of the peripheral retina after surgery.

Capsulorrhexis should therefore be large, which means the optic should be at least 6 mm in size.

Table 1 Treatment of cataract surgery patients who have diabetes.

Diagnosis	Management
No diabetic retinopathy (DR)	Discharge to annual screening
Mild, non-proliferative DR (NPDR)	Discharge to annual screening or observe in clinic
Severe NPDR	Pan-retinal photocoagulation laser or anti-VEGF injections (when patients have to travel a long way), otherwise observe in clinic and perform fundus fluorescein angiography
Proliferative DR	Pan-retinal photocoagulation laser or anti-VEGF
Diabetic macular oedema (DMO) and NPDR	Anti-VEGF with or without pan-retinal photocoagulation laser
DMO + PDR	Anti-VEGF and pan-retinal photocoagulation laser
Diabetic maculopathy	NSAIDS or pan-retinal photocoagulation laser or anti-VEGF or steroids

Postoperative care

Ideally, patients with diabetes who have recently undergone cataract surgery should undergo a careful eye examination, including a detailed fundus examination, to check for excessive inflammation and signs of diabetic eye disease. Offer treatment as shown in Table 1.

Discussion

Cataract surgery in patients with diabetes is a complex subject. The level of retinopathy at the time of surgery, complicated or uncomplicated surgery and diabetic control all have a potential impact on the progression of diabetic eye disease.

Despite these risks, cataract surgery may be necessary to allow the person to function effectively and improve their adherence to their prescribed diabetic medication regimen. Surgery may also be necessary in order to make it possible to treat diabetic eye disease using pan-retinal photocoagulation laser or other treatment options.

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Managing cataract surgery in patients with uveitis

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Cataract surgery in patients with uveitis has multiple challenges, of which control of inflammation is the most important.

Long-standing intraocular inflammation (uveitis) leads to the formation of cataract (Figure 1), as does prolonged steroid use. There are multiple surgical challenges in managing uveitic cataract, such as the presence of posterior synechiae, atrophic iris, small pupil, pupillary membrane, fibrous anterior capsule, mature cataract, new vessels in the angle and zonular weakness. Postoperative inflammation, macular oedema and glaucoma are also more frequent in uveitic cataracts. This article will address these issues, but probably the most important issue of all is the control of inflammation preoperatively and its role in determining the surgical and visual outcome.

Preoperative control of inflammation

As uveitis is commonly associated with systemic conditions, it is important to control systemic inflammation, if present. This frequently requires a multidisciplinary approach. It is necessary to have at least 3 months of quiescence (stable treatment without signs or symptoms of inflammation) in order to have a successful surgical outcome.

Uveal inflammation is said to be controlled when there is no vitritis and no cells in the anterior chamber. A small amount of residual flare is quite common, even if the inflammation is well controlled, as long-standing inflammation leads to the breakdown of the blood-aqueous barrier.

Surgery for uveitic cataract must take place under steroid cover. Start the patient on 1 mg/kg/day of oral prednisolone at least one week before surgery. An alternative strategy would be to intensify the use of topical steroid for 1–2 weeks before the operation. For example, give prednisolone eye drops 1% eight times a day for ten days and then, on the day of surgery, give an intravenous infusion of 500 mg methylprednisolone in 100 ml normal saline over 45–60 minutes. In more significant inflammation, consider immunosuppressive drugs. Some surgeons also prefer to start topical non-steroidal anti-inflammatory drugs (NSAIDs) one week before surgery.

A thorough retinal and posterior segment examination is necessary to look for macular oedema, optic atrophy, macular scarring, choroidal neovascular membrane and epiretinal membrane. Retinal complications can cause poor visual outcomes and often need to be treated preoperatively. In patients with mature cataract and dense posterior subcapsular cataract, ultrasonography is a useful tool to detect vitritis, the presence of retinochoroidal complex thickening, exudative retinal detachments and disc oedema.

In well-resourced settings, optical coherence tomography of the retina can help to document and monitor macular pathologies before surgery. Ultrasound biomicroscopy helps to assess pars planitis, uveal effusions, ciliary body traction, ciliary body atrophy and the presence of cyclitic membranes, especially in patients with hypotony. Some surgeons use a potential acuity meter to measure the potential improvement in visual acuity in patients with advanced cataract.

Figure 1 Cataract in a patient with uveitis

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Figure 2 Intraoperative mechanical dilation of the pupil using Kuglen's hooks

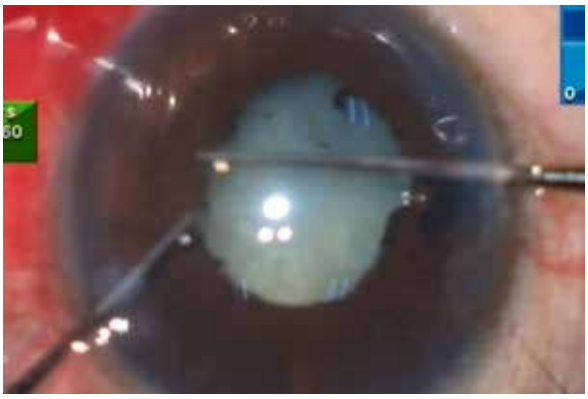

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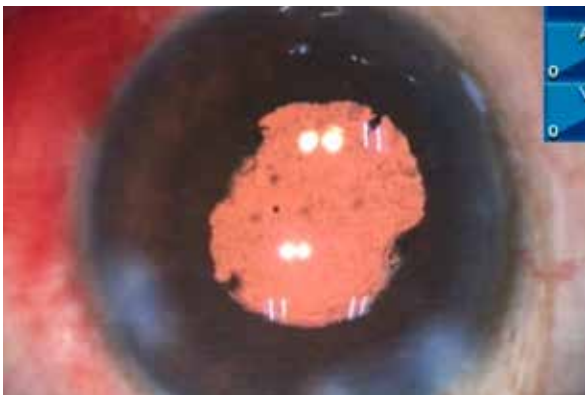
Figure 3 End of the procedure with PCIOL placed in bag



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Uveitic glaucoma

Raised intraocular pressure and glaucoma can be caused by uveitis or prolonged steroid use. Resist the temptation to combine cataract surgery with a drainage procedure. The failure rate for the drainage surgery will be very high, and the chance of subsequent successful glaucoma surgery will be reduced.

Intraoperative management

The type of anaesthesia depends on the surgeon's preference, local factors and the presence of posterior synechiae. Surgery can occasionally be performed under topical anaesthesia; for example, in patients with posterior subcapsular cataract associated with Fuch's uveitis. However, if iris manipulation is required, then retrobulbar, sub-Tenon's or peribulbar blocks are preferable.

Both manual small-incision cataract surgery and phacoemulsification are found to be comparable in terms of endothelial cell loss and complication rates.[1] Careful consideration of surgical strategy is essential if there is any sign of corneal endothelial dystrophy, or if phacoemulsfication is being used with a dense cataract (pp. 86–87).

Small pupil is a big challenge when operating on uveitic cataract. Pupillary membranes can be transected with capsulorrhexis scissors, and then removed with capsulorrhexis forceps prior to mechanical dilation of the pupil using Kuglen's hooks (Figure 2) or similar devices (pp. 84–85).

Iris manipulation must be done gently, as excessive manipulation can increase pigment dispersion, postoperative inflammation and hyphaema, and can result in permanent pupillary dilation. We recommend doing a large capsulorrhexis, because postoperative anterior capsular phimosis is more frequent in uveitic eyes. It is preferable to place the posterior chamber intraocular lens (PCIOL) in the bag (Figure 3), and not in the sulcus, in order to prevent postoperative iris irritation.[2]

Postoperative capsule contraction and IOL selection

Capsule contraction after surgery can lead to anterior capsular phimosis, zonule rupture and, in severe cases, even lens dislocation. Polymethylmethacrylate (PMMA) intraocular lenses (IOLs), or foldable IOLs with PMMA haptics, minimise capsule contraction compared to IOLs with prolene haptics. Capsular tension rings also help to prevent contraction.

The choice of IOL is important for other reasons also:

- Hydrophobic acrylic IOLs are well tolerated in uveitic eyes and reduce the rate of posterior synechiae formation.[3]
- Heparin surface modified IOLs (HSM-IOLs) may be associated with a reduced rate of postoperative uveitis. Angulated IOL haptics help to reduce the amount of contact between the iris and the optic.[4]
- In aggressive uveitis, such as Behcet's and juvenile rheumatoid uveitis, inserting an IOL during cataract extraction has shown only moderate success and aphakia should be considered, especially in younger age groups.

In Fuchs' uveitis and non-granulomatous inflammation , inserting an IOL during the primary procedure is shown to be safer.[5]

Postoperative vitreous opacification is another frequent complication in uveitic eyes. Remove the cataract first and later, after assessing the impact of vitreous opacification on vision, decide whether or not to perform pars-plana vitrectomy.[5]

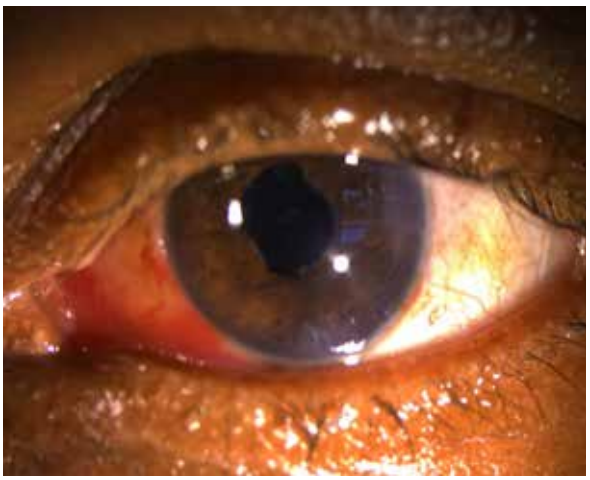

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Image of the patient two days after surgery.

Postoperative management

Aggressive control of inflammation is recommended after cataract surgery in uveitic eyes. Instil topical steroids hourly at first, and then taper the dose as per the response. Cycloplegics can be added for the first two weeks, as they reduce the ciliary spasm, stabilise the blood-aqueous barrier and prevent the formation of posterior synechiae.

Intraocular pressure rise, due to steroid response and inflammation, must be monitored and treated with topical antiglaucoma medications. Prostaglandin analogues should be avoided as they increase inflammation. Beta blockers, and topical and oral carbonic anhydrase inhibitors, can be safely used to manage the IOP spikes. Postoperative iris bombe (apposition of the iris to the IOL or anterior vitreous, preventing aqueous from flowing from the posterior to the anterior chamber), due to occlusio or seclusio pupillae, is treated with YAG laser peripheral iridectomy.

Other complications which lead to reduced vision are cystoid macular oedema, epiretinal membranes (ERM) and posterior capsular opacification.[6] Cystoid macular oedema can be treated with topical steroids and NSAIDs at first. In unresponsive cases, we recommend posterior sub-Tenon's injection of triamcinolone (up to 40 mg in 1 ml) or intravitreal steroid preparations. Late complications, such as a thick epiretinal membrane, can cause significant pucker and visual deterioration. These patients can be referred to a vitreoretinal surgeon for an ERM peel. Postoperative cyclitic membranes and hypotony require pars plana vitrectomy and membranectomy. Another late complication is posterior capsular opacification which can be treated with YAG capsulotomy several months after the operation, once the inflammation is quiescent.

In paediatric uveitic cataract, visual outcome can be poor due to amblyopia and recalcitrant inflammation.

In conclusion, managing cataract in patients with uveitis is a challenge. However, with good preoperative assessment and adequate control of inflammation, good surgical visual outcomes can be achieved. Speak to the patient at every step about the visual prognosis, the pros and cons of treatment, and the risks factors associated with surgery. This adds to patients' satisfaction – which is of prime importance to the operating surgeon.

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Managing cataract surgery in patients with small pupils

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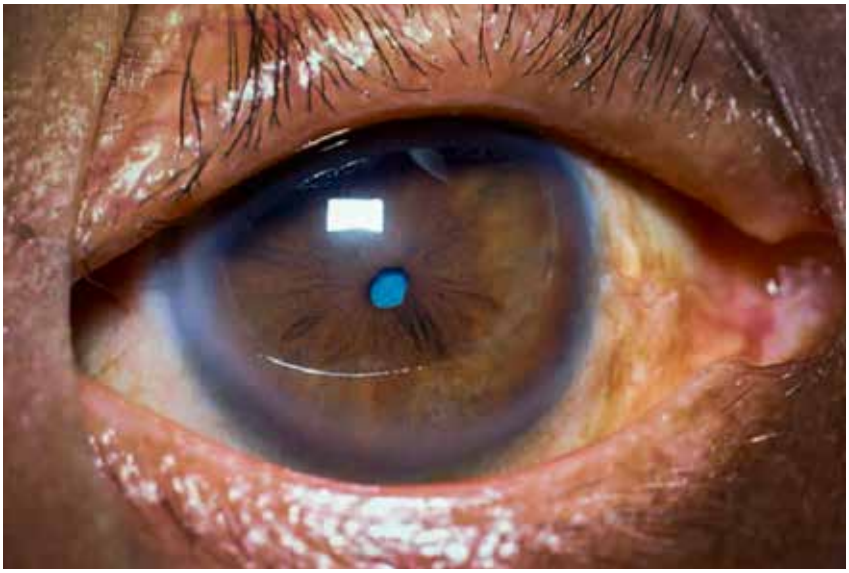
Cataract surgery is more difficult when a patient has a small pupil, but optimising pharmacological dilation and adapting your surgical technique can ensure good outcomes.



MARGREET HOGEWEG

Small pupil.

Removing a cataract, typically around 10 mm in diameter, is made much more difficult when a patient has a small pupil; the risk of rupture of the posterior capsule during surgery is also 50% higher.[1] Pre-operative action can sometimes improve this situation, but the solution frequently involves changes in surgical technique.

Before surgery

Take a careful history and ask patients about the medication they are currently using.

- **Oral alpha blocker medication**, such as tamsulosin or doxazosin, help urinary symptoms by relaxing the smooth muscles of the bladder neck. They also affect the iris, causing poor dilation and intraoperative floppy iris syndrome (IFIS). The amount of IFIS does not seem to be related to the dose or the duration of the therapy,[3] so stopping these medications, even several months before surgery, often does not reverse this effect.
- Patients using **topical pilocarpine** should be asked to stop at least three weeks before surgery.

Pre-operative NSAID drops, such as ketorolac, nepafenac or diclofenac, instilled 30–90 minutes before surgery, have been shown to maintain pupil dilation during surgery.

Where **posterior synechiae** are present, consider whether these were caused by uveitis, rather than by previous infection, surgery or trauma. If they were caused by uveitis, aggressive management of peri-operative and postoperative inflammation will be essential for obtaining a good outcome. Careful consideration should be given to IOL choice, or even aphakia, especially in younger patients with uveitis (pp. 82–83).

Pharmacological dilation

Avoid dilating more than 1–2 hours before surgery as the dilation effect wears off and subsequent drops work less well.

Optimal dilation can be promoted by putting little pieces of surgical sponge or cotton wool soaked in 10% phenylephrine, or a mixture of phenylephrine and cycloplegic eyedrops, into the inferior fornix 30 minutes before surgery. Be sure to remove these before the procedure.

Maintaining dilation

Many eye units routinely add 0.5 ml of preservative-free adrenaline (1 mg/ml) to 500 ml of balanced salt solution or Ringer's lactate to help maintain dilation during cataract surgery; for patients who have a small pupil or a floppy iris, stronger intracameral agents can be used.

Phenylephrine (prepared from 2.5% or 10% preservative-free drops) can be prepared with concentrations ranging from 0.5% to 1.5%. Adequate mixing of agents must be ensured by using 2.5 ml or 5 ml syringes only (avoid 1 ml syringes). It may be preferable to use 10% phenylephrine as this ensures greater dilution of other agents contained in the drops.

Example preparation guidelines might be:

- 2 drops (approximately 0.1 ml) of 10% preservative-free phenylephrine added to 1–2 ml of balanced salt solution, or
- 0.5 ml of 2.5% preservative-free phenylephrine diluted with 1 ml balanced salt solution.

If additional anaesthetic is also desired, a version of epi-Shugarcaine[2] can be produced as follows:

- 9 ml of balanced salt solution
- 3 ml of 4% preservative-free lidocaine
- 4 ml of 1:1,000 preservative-free, bisulfite-free epinephrine.

If you need a smaller quantity, mix 1 ml of 4% preservative-free lidocaine with 3 ml of balanced salt solution, then discard 1 ml of this mixture and add 1 ml of preservative-free epinephrine.

Continues overleaf ➤

Surgical/mechanical dilation

Even after pharmacological interventions, many patients will still have pupils that are too small.

If the pupil is fixed with posterior synechiae, you will need to break them with an iris spatula or with any other blunt instrument.

If the pupil size is fixed due to fibrosis, try to remove the fibrotic tissue using Utrata forceps.

If those measures are not sufficient, then you will have to enlarge the pupil mechanically. There are several options for doing this.

1. Pupil stretch

Stretch the pupillary sphincter using two instruments (such as Lester hooks) through two anterior chamber paracenteses. Engage the pupillary margin at opposite points and stretch the pupil to the limbus for a few seconds. This can be repeated 90° apart. Some bleeding can result, and the pupil may be permanently dilated or distorted.

2. Radial iridotomy

To preserve a round pupil, a radial iridotomy can be made. First, make a small peripheral iridectomy and then extend the cut to the pupillary margin. Suture afterwards using 10-0 non-absorbable interrupted sutures (Figure 2). The procedure demands considerable skill and patience.

3. Sphincterotomy

Make several small cuts on the pupillary sphincter to allow room for the cataract to pass through (Figure 3). After the small cuts are made, deepen the anterior chamber with viscoelastic to achieve the dilation. A sphincterotomy is usually not necessary if you stretch the pupil.

4. Iris hooks

Use four or five iris hooks, spaced evenly apart. You can make your own ones using 27- or 30-gauge cannulae and pieces of rubber. However, it is complicated to make them yourself, and potentially expensive to purchase, so pupil stretching is often preferable.

5. Other devices

Other devices, such as Malyugin rings, can enlarge the pupil to 6.25 or 7 mm, which is large enough for phacoemulsification but often not for SICS or ECCE.

Postoperative care

When any surgical intervention is used to mechanically dilate the pupil, expect an increase in postoperative inflammation and take post-operative anti-inflammatory measures, such as sub-conjunctival steroid injection at the end of the procedure, using a more potent topical steroid postoperatively, or instilling drops more frequently (e.g., dexamethasone 0.1% or prednisolone 1% six times a day).

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4 **www.cataractcoach.com**

Figure 1 Place the instruments 180°apart and stretch the pupil towards the limbus, as shown[4]

Figure 2 Radial iridotomy (left). Suture with 10.0 interrupted sutures (right)

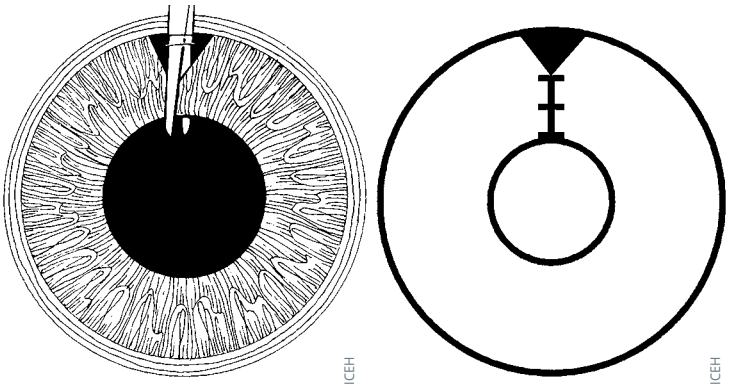


Figure 3 Sphincterotomy

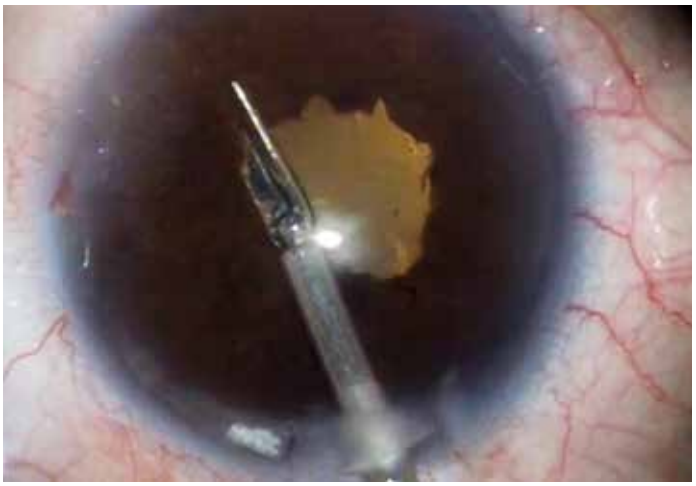
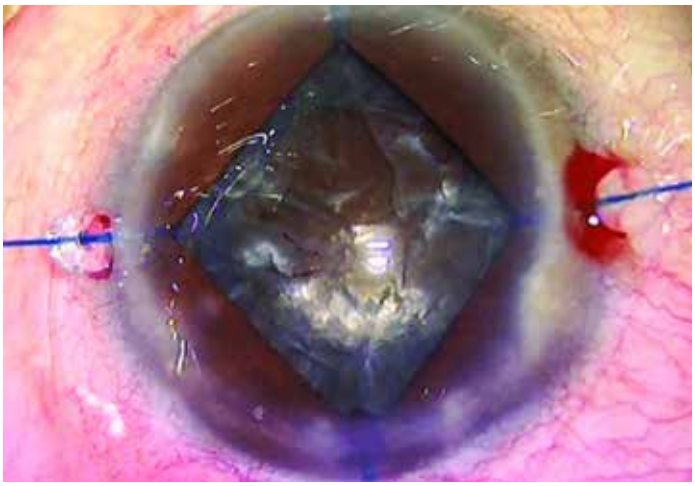


Figure 4 Iris hooks



Cataract surgery in patients with Fuchs' endothelial corneal dystrophy

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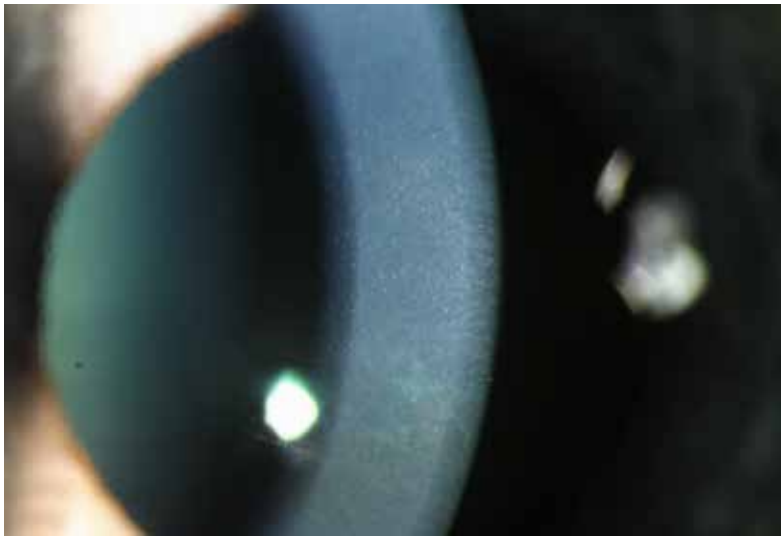
Cataract surgery risks corneal decompensation in patients with Fuchs' endothelial corneal dystrophy, but it can also be combined with endothelial keratoplasty to address the condition.



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Guttae can have a dimpled or 'beaten metal' appearance at the slit lamp.

Fuchs' endothelial corneal dystrophy (FECD) is a progressive disease which mainly affects Descemet's membrane and the endothelium and may eventually lead to corneal decompensation and decreased vision. FECD is treated by performing endothelial keratoplasty: replacement of the diseased inner cell layer of the cornea using donor tissue, e.g., Descemet's stripping endothelial keratoplasty (DSEK).

Presentation

It is not uncommon to come across patients with both FECD and cataract in clinical practice. The exact prevalence of FECD is not known. It has extreme geographical variability with higher prevalence in European countries and a lower prevalence in South America, Asia and Australia. It is the most prevalent corneal dystrophy in the United States of America.[1]

Patients with FECD often complain of visual loss, which may be attributed to either cataract and/or FECD. Visual loss due to FECD is usually worse in the morning and improves as the day progresses. This is because corneal oedema increases in the night during sleep and reduces as the tear film gradually evaporates during the day. Glare is often a disturbing symptom; it occurs due to confluent guttae or pigment adherent to the endothelium.

Detection

The presence of guttae is a common sign of endothelial dystrophy. Guttae are excrescences of collagen produced by stressed corneal endothelial cells (see main image above); they form in the middle of the cornea and eventually spread throughout it.

Early cases of FECD may be missed during a cursory slit lamp examination in a busy clinic. Take a careful history of the patient's symptoms and ask whether these are worse in the morning. If possible, examine the eyes under high magnification to detect the condition early.

Pre-operative considerations

Cataract surgeons are faced with the dilemma of determining whether a cataract operation alone will improve a patient's symptoms, or whether there is a risk that cataract surgery will cause the cornea to decompensate and should therefore be combined with endothelial ketaroplasty. Personalise the treatment plan and consider individual factors such as the cataract density, the health and thickness of the cornea, the anterior chamber depth and the size of the dilated pupil.

The presence of microcystic oedema, stromal thickening and a low central endothelial cell count (less than 1,000 cells/mm^2), by specular microscopy, indicates an increased likelihood of corneal decompensation after cataract surgery. In these patients, cataract surgery should be combined with endothelial keratoplasty.

In most low- and middle-income countries, a specular microscope might not be widely available. In these situations, central corneal thickness can be used as indirect evidence of endothelial health. This is because dysfunctional endothelial cells are unable to pump water out of the cornea effectively and the corneal stroma swells, thereby increasing the thickness of the central cornea. However, central corneal thickness is variable in the normal population and corneal oedema can still be present in eyes with normal corneal thickness.

In practical terms, central corneal thickness of greater than 640 microns, usually measured using an ultrasound pachymeter, may be predictive of corneal decompensation; this means that a combined operation is needed.[2]

Patient counselling

Patient counselling is essential for a positive outcome. Allow enough time for counselling and make sure the patient understands that:

- Postoperative recovery time may be longer than usual.
- Endothelial keratoplasty may be required in case of corneal decompensation.
- They will have to come for regular follow-up visits (tell them where to go, and when, and what financial support is available to cover transport costs).

Technical considerations

Choice of intraocular lens

If endothelial keratoplasty is combined with cataract surgery, we recommend using a standard monofocal, aspheric intraocular lens (IOL) with larger optic diameter (6.0 mm minimum). Endothelial transplantation introduces negative asphericity and reduced contrast, so avoid the use of multifocal IOLs.

Endothelial transplant patients undergo a hyperopic refractive shift. Thus, where the expectation of decompensation is very high, the IOL power is calculated with a target refraction of -1.25 D. Avoid using an anterior chamber IOL if there is a posterior capsular tear.

Choice of surgical technique

Both manual small incision cataract surgery (SICS) and phacoemulsification result in a similar amount of endothelial loss.[3] The choice of surgical technique is hence debatable and depends on the cataract density, the status of cornea and the surgeon's experience and familiarity with each technique. The authors personally prefer phacoemulsification as it has several advantages (small incision, closed anterior chamber and use of phaco power modulation and fluidics to minimise cell loss). Other surgeons, with greater experience of manual SICS than phaco, may prefer the SICS technique. SICS may indeed be the better option when done by surgeons with a great deal of experience in this technique, particularly in patients with very dense cataract, small pupil and compromised zonules.

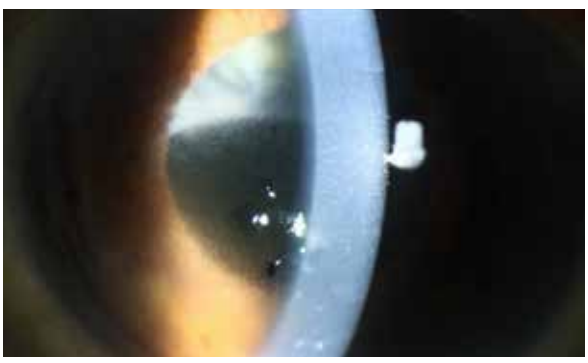
The newest addition to the cataract surgery technological portfolio is the femtosecond laser, which can be used to create a capsulorrhexis and divide the nucleus into fragments. This option is expensive and has not yet been shown to produce better outcomes than conventional surgery, so it has not become routinely used, even in the most intensively resourced health economies.

Choice of viscoelastic

A chondroitin sulfate-based dispersive viscoelastic should be used to protect the cornea. It is important to coat the endothelium before doing capsulorhexis. The soft-shell technique, of using a dispersive viscoelastic against the endothelium, followed by a super-cohesive viscoadaptive agent, is particularly effective. Complete removal of viscoelastic must be ensured to prevent a rise in intraocular pressure after surgery.

Choice of irrigating solution

The choice of solution may also contribute to endothelial cell survival. In units where Ringer's lactate may be the routine choice, Balanced Salt Solution (BSS) would be preferable for FECD patients. BSS, or another solution that contains glutathione, sodium bicarbonate and glucose, will create a more physiologic environment and minimise endothelial cell loss.



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Corneal oedema and bullous keratopathy following cataract surgery. Notice the diffuse epithelial microcysts with several larger bullae visible to the left of the slit beam.

Wound closure

With compromised endothelial cell function, incisions may not seal securely and placing a suture would be better than excessive corneal stromal hydration.

Postoperative care

Whatever the technique used to preserve endothelial cells, there is always the risk of prolonged, significant postoperative corneal oedema. These patients may require more frequent steroids and hypertonic saline (e.g. 5% NaCl drops) to help reduce corneal oedema. Periodic follow-up is recommended to evaluate corneal clarity. An excellent visual outcome can be expected in many patients, even those with low pre-operative endothelial counts.[4]

Take home message

- If central corneal thickness is greater than 640 micrometers, endothelial cells are fewer than 1,000 cells/mm^2 and/or there is microcystic oedema: consider combining the cataract operation with endothelial keratoplasty.
- Base the choice of cataract surgical technique on the surgeon's experience with the surgical technique, the density of the cataract and the health of the cornea.
- If using phaco, advanced phaco parameters, phaco chop, soft shell technique and the use of a transverse/torsional phaco tip are advocated.
- Pre-operative patient counselling is essential in order to ensure a positive outcome.

With thanks to EyeRounds.org for their generous contribution of images for this article. www.eyerounds.org

Tips for phaco

Minimising endothelial cell loss during phaco

While performing phacoemulsification, the best way to decrease ultrasonic energy is to use a mechanical method, such as chopping, to break apart the nucleus. Adjust the power modulations to enable the phaco machine to deliver shorter pulses or bursts of ultrasonic energy that minimise endothelial cell loss. Whereas the foot pedal of the phaco machine can deliver blocks of 1 or 2 seconds of energy, the power modulations allows much smaller increments, such as 2 to 4 milliseconds. It is advisable to always use a new phaco tip in these cases and combine lateral phaco (transverse or torsional), with longitudinal phaco.

When to operate

All anterior segment intraocular procedures tend to cause at least some loss of endothelial cells. In the early stages, cataracts tend to be less dense and therefore require less ultrasonic energy for phacoemulsification. In the advanced stages of cataract, the ultrasonic energy, combined with the fluid flow through the anterior chamber, may cause a higher degree of endothelial cell loss. It may therefore be appropriate to perform a cataract operation at an earlier stage if phacoemulsification is an option.

Viscoelastic

Viscoelastic should be periodically re-injected into the anterior chamber as the irrigation fluid can wash it away during phacoemulsification.

Irrigation

The flow of irrigating solution can create currents against the endothelial cells, inducing damage. Use low-flow parameters, make snug incisions and stay away from the corneal endothelium.

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Managing cataract surgery in patients with glaucoma

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Cataract and glaucoma can co-exist. Learn about cataract surgery in patients with previous trabeculectomies, and when (and how) to combine cataract and glaucoma surgery.

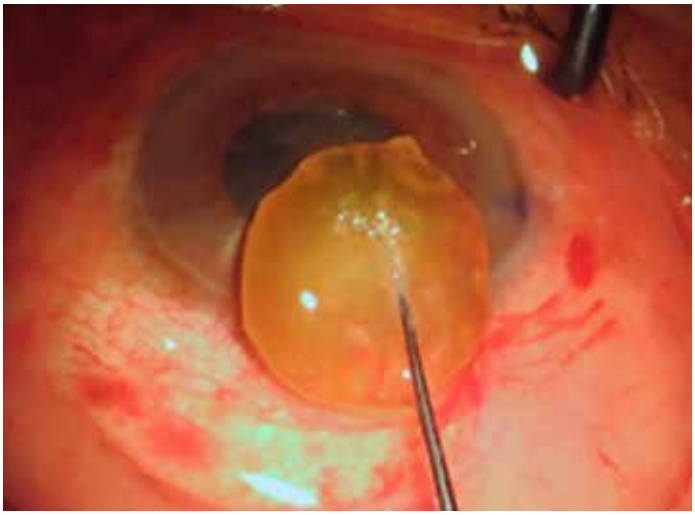


FIGURE: FROM KHANDELWAL RR ET AL. EYE (LOND). 2015;29:363-70

Cataract and glaucoma surgery can sometimes be combined.

Cataract and glaucoma are leading causes of blindness and visual impairment. Both conditions are age-related and thus they may co-exist. Cataracts may also cause glaucoma (phacomorphic glaucoma) and cataract may be accelerated as a result of glaucoma surgery.

When cataract co-exists with glaucoma, cataract may be the trigger for seeking health care because the patient notices the coudy vision and white pupil caused by cataract, whereas the gradual visual loss due to glaucoma often occurs without the patient being aware of it until the glaucoma is in its advanced stages.

Glaucoma medication can increase the negative symptoms of cataract, such as miotics (e.g. pilocarpine), which can make the vision worse, and adrenergics, which can increase glare due to a degree of pupillary dilation.

In a patient with cataract, it is important to assess the optic nerve head to exclude glaucoma. If there is no view of the optic disc, other signs, such as relative afferent pupillary defect (RAPD) and raised intraocular pressure (IOP), may indicate co-existing glaucoma.

Cataract extraction, by whichever method, may be combined with any surgical glaucoma technique, including trabeculectomy, glaucoma drainage devices, minimally invasive glaucoma surgery (MIGS), and laser procedures such as endoscopic cyclophotocoagulation (ECP). **Note:** combined surgery is not recommended in patients with uveitic glaucoma (p. 82).

Performing glaucoma surgery alone may accelerate the cataract, which means the patient will need a cataract operation soon. Performing cataract surgery alone may lower the intraocular pressure (IOP) independently,[1] but this is inconsistent, especially in poorly controlled glaucoma with severe visual field loss.[2] There is inconclusive evidence of an increased risk of complications in combined surgery over cataract surgery alone, and information about long-term outcomes (follow-up of five years or more) is not available.[3,4]

Whether cataract surgery is done after trabeculectomy surgery (at least six months after) or combined with trabeculectomy surgery, the **pre-operative assessment** should include counselling to help patients understand that the visual outcome of their operation will depend on the degree of optic nerve damage they have. Keep their expectations modest. Inform patients about the possibility of **bleb failure**[5] and that **glaucoma medications** may still be required postoperatively, in the long term.

Cataract surgery for patients who have had previous trabeculectomy

This is regarded as complicated cataract surgery, requiring thorough preoperative examination and preparation, a surgical plan and proactive postoperative care.[6,7]

Note the following:

- Visual symptoms (e.g., glare, haloes around lights), **visual acuity**, and the possible causes of reduced vision (due to the contribution of the cataract and/or the progression of glaucoma).
- The **severity of the glaucoma**. Estimate optic disc cupping, which is visible if the lens opacity is not dense. The current IOP will determine target IOP and predict the need for another glaucoma intervention.
- The number and frequency of **glaucoma medications** currently used to control IOP. This may indicate whether the bleb is fully functioning or not.
- The number and type(s) of **previous surgery** and the presence of any drainage device. For recent trabeculectomy or implant, it is advised to delay cataract surgery until the bleb matures (at about six months).
- The **bleb** position will determine the approach for the cataract surgery incision, which should avoid the bleb area. Note whether the bleb is functioning, and whether it is cystic or flat and/or fibrosed or vascularised. This will determine whether intraoperative bleb revision is required.

- The position of the **peripheral iridectomy** and the pupil's ability to dilate. Iris manipulation during cataract surgery with floppy iris or poor dilation due to posterior synechiae may increase the risk of postoperative inflammation, which may compromise bleb function.
- **Pseudoexfoliation**, as this may be associated with weak zonules, which is a reason for caution in cataract surgery.
- **Previous surgery**, which may also cause weak zonules and vitreous disturbance, as well as **corneal endothelial cell loss**, which poses a greater risk of postoperative corneal oedema and decompensation.

Intraoperatively, use extra caution and pay attention to the following:

- **Care of the existing bleb**, especially if thin and cystic, during placement of the lid speculum and any physical manipulation or instrumentation of the eye during wound incision and paracentesis.
- **Bleb revision**, if needed. This can be done using needling and/or additional application of antimetabolites.
- **Maintaining the anterior chamber (AC) depth**, especially in patients with a high functioning bleb. Take extra caution to prevent posterior capsular rent and vitreous loss. Ensure that any tube that is in place is not blocked, obstructed or displaced.
- **Review a functioning tube**, if present. It can be repositioned or flushed to improve the chances of it functioning after surgery. It may also be trimmed if too long.
- **IOL placement.** The aim is to place the IOL in the bag; otherwise, be prepared for a sulcus placement if the capsule or zonules are compromised. Position the lens so that the haptic is away from the primary incision (to avoid it migrating into the AC). Avoid AC IOLs because they can directly affect the bleb and may produce undue postoperative inflammation.
- **AC washout.** Thoroughly remove viscoelastic as well as nuclear and cortical lens material. This will prevent blockage of drainage channels and/or tubes and reduce postoperative inflammation and IOP spikes. However, take care to prevent excessive flushing against the corneal endothelium as this can cause damage.
- **Wound closure.** Use sutures to produce a watertight wound. A wound leak will increase the risk of bleb failure.

Proactive postoperative care involves regular visits and long-term follow-up to assess IOP, visual fields, and bleb morphology and function.

- Watch out for **bleb failure** – examine for bleb leak and aqueous misdirection. Actively check for retained lens fragments or iris incarceration in the sclerectomy site that may cause blockage.
- Aggressively treat postoperative inflammation to **prevent fibrosis**. At the end of surgery, give an extra subconjunctival corticosteroid injection (e.g. 4 mg dexamethasone). Avoid miotics and prostaglandins and use more postoperative steroid eye drops (e.g. dexamethasone hourly) and non-steroidal anti-inflammatory eye drops (e.g. diclofenac).
- Measure the IOP regularly and treat **IOP spikes** with appropriate glaucoma medications.

Combined cataract and glaucoma surgery

Combined cataract and glaucoma surgery may be the procedure of choice if the skill of the surgeon is adequate, the patient understands the procedure and expected outcomes, and there will be good and regular follow-up. Consider combined surgery when:

- There has been no previous glaucoma surgery.
- There is a definite surgical indication for glaucoma surgery, such as angle-closure glaucoma with co-existing cataract.
- Cataract surgery alone is likely to increase the IOP in the patient with glaucoma. This may be the case in patients with poorly controlled glaucoma and/or severe visual field loss.
- It is more cost-efficient to do combined surgery; for example, if there is a one-off payment for surgery and/or a reduction in the number of glaucoma medications used.
- Patients are deemed unlikely to come back for the second operation if the cataract and glaucoma operations are done separately.
- There is an opportunity to provide glaucoma surgery for patients who were initially reluctant until vision loss from cataract influenced their decision to have surgery.
- It is preferable to offer combined surgery because of increased anaesthetic/surgical risks due to other systemic conditions such as hypertension, diabetes, asthma and thyroid disease.

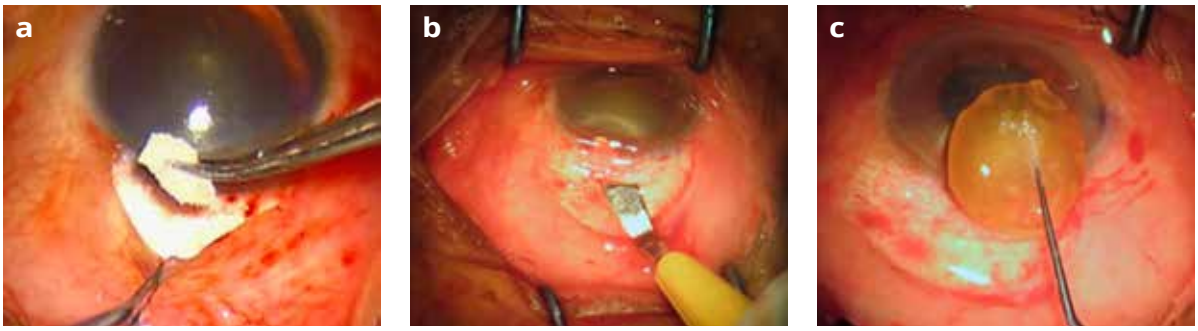
The safe surgery system trabeculectomy combined with cataract extraction (either manual small-incision cataract surgery (MSICS) or phaco-emulsification) was developed by Moorfields Eye Hospital. It has been demonstrated to result in excellent IOP control with minimal postoperative complications.[8] There was a success rate of at least 50% for achieving IOP of ≤12 mmHg, and a success rate of up to 90% for achieving IOP ≤18 mmHg. The technique offers an acceptable option for surgical treatment in patients with cataract and coexisting glaucoma in low- and middle-income countries. Another possible solution in countries where laser facilities are available, is combined cataract surgery with endoscopic cyclophotocoagulation (ECP),[9] especially where the risks of trabeculectomy with mitomycin C (MMC) are higher (e.g., in eyes with a thin conjunctiva or secondary glaucoma). This may be performed as a two-site procedure or through the same superior incision.

The steps of the safe surgery system trabeculectomy technique with modifications to combine it with surgery (MSICS), adapted from Khandelwal et al,[8] are described below and in Figure 1 (a–f).

A Preparing the scleral area for trabeculectomy

1 Use peribulbar anaesthesia or a retrobulbar block.
2 Clean the periocular area with 5% povidone iodine for 3 minutes.
3 Insert a superior rectus traction suture with 6-0 silk, taking care not to damage the conjunctiva.
4 Dissect a fornix-based conjunctival flap superiorly and separate the Tenon's capsule. Note: a temporal/nasal position may be considered to allow for possible repeat glaucoma surgery.
5 Dissect the conjunctiva backwards for about 8–10 mm to allow for the application of MMC sponges.
6 Insert three MMC (0.2 mg/ml) folded soaked sponges in the sclera, keeping away from the edges of the conjunctiva.
7 Remove the sponges after two minutes and thoroughly irrigate the area with 20 ml Ringers lactate or normal saline solution.

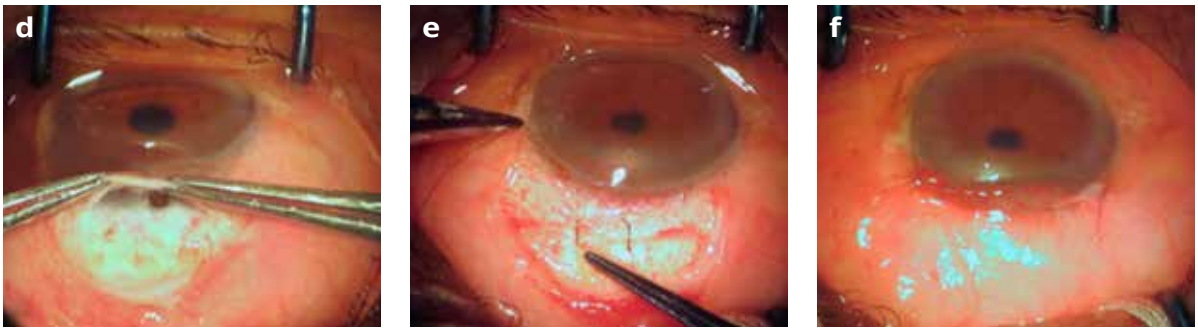
Figure 1 Intraoperative photograph showing surgical procedure of MSICS–trabeculectomy



a Fornix-based conjunctival flap with diffuse and posterior application of MMC (0.2 mg/ml, for 2 min), without touching the conjunctival edges.

b Partial thickness scleral tunnel, 3 mm posterior to the limbus, and 1–2 mm into the clear cornea with scleral pockets on the sides

c The nucleus delivered using the 'sandwich technique'.



d Trabeculectomy performed by excising a block of 0.5-mm tissue from the posterior lip of the scleral tunnel using a Kelly's Descemet's membrane punch.

e The scleral flap closed with adjustable 10-0 nylon sutures for minimal spontaneous filtration.

f The conjunctival incision closed using 8-0 vicryl sutures in a watertight manner.

FIGURE: FROM KHANDELWAL RR ET AL. EYE (LOND). 2015;29:363-70

B Performing the MSICS

1 At about 3 mm posterior to the corneal limbus, use a crescent blade to make a partial thickness scleral tunnel of 5–7 mm in width.
2 Continue the dissection for 1–2 mm into the clear cornea with the scleral pockets continued in the same plane. Leave the sides of the scleral tunnel intact.
3 Make a temporal corneal paracentesis and inject viscoelastic.
4 Perform a capsulorrhexis of about 5–6 mm through the side port.
5 From the scleral tunnel position, enter the anterior chamber with a 3.2 mm keratome at 12 o'clock to enlarge the inner lip to 8-9 mm wide.
6 Using hydrodissection, rotate and prolapse the lens nucleus into the anterior chamber using a Sinskey hook.
7 Deliver the nucleus with an irrigating vectis or with a wire vectis and a Sinskey hook. Use the sandwich technique after injecting generous viscoelastic above and below the lens nucleus.
8 Aspirate the remaining cortex using a two-way irrigation-aspiration simcoe cannula.
9 Insert an IOL, placed in the bag and rotated such that the haptics are positioned horizontally and away from the scleral incision.

C Performing the trabeculectomy

1 After insertion and positioning of the IOL, aspirate the viscoelastic and inject acetylcholine to constrict the pupil.
2 Excise a block of 0.5 mm tissue from the posterior lip of the scleral tunnel. A Kelly's Descemet's membrane punch or similar device can be used, where available.
3 Follow with a peripheral iridectomy corresponding with the inner scleral flap.
4 Close the scleral tunnel with two adjustable 10-0 monofilament nylon sutures inserted on either side of the punch area. This is the key step for the safe surgery system trabeculectomy. Note: make four throws when tying the suture.
5 For brown and hard nuclei, where the scleral tunnel is enlarged at the sides, insert additional interrupted sutures at the corners of the scleral tunnel.
6 Close the conjunctiva with 10-0 nylon suture using anchoring corneal suture technique to produce a watertight closure under tension.
7 Test the patency of the trabeculectomy by injecting Ringers lactate or normal saline through the side port to observe the formation of a diffuse conjunctival bleb without a leak.
8 Inject subconjunctival dexamethasone and antibiotics in the inferior fornix.

D Postoperative care

Postoperatively, patients are treated with antibiotic eye drops (e.g. ciprofloxacin 0.3%) four times a day, corticosteroid eye drops (e.g., dexamethasone 0.1% or prednisolone acetate 1%) six times a day for one week and tapered over two months. Cycloplegics may be used to reduce discomfort. The use of anti-glaucoma medication will depend on the IOP.

The preferred postoperative examination schedule is at postop Day 1, Day 3, at one week, at one month, at 3 months and thereafter scheduled at reasonable intervals, as required. At each visit, the best corrected visual acuity, IOP and complications, if any, are noted.

In addition to applying the basics of good postoperative care after glaucoma surgery,[10] be alert for the symptoms and signs of complications of cataract surgery.

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Improving the practice of cataract surgical outcome measurement

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A successful cataract outcome monitoring and continuous quality improvement system will assist practitioners and centres to identify and implement ongoing improvements in eye care delivery.

THE FRED HOLLOWS FOUNDATION: ALDRENE TAN

Monitoring surgical quality allows clinicians and administrators to identify issues and take action to improve practice, outcomes and performance. LAOS

A study from Kenya[1] showed that monitoring the visual outcomes of cataract surgery is associated with improving those outcomes. This suggests that we need to know how well our patients see after surgery to have the motivation and information to improve surgical results. Tools to help with this monitoring process, both paper-based and computer-based, have been developed and made freely available.[2] However, the practice of monitoring outcomes has not yet become a routine part of running ophthalmic services other than in situations where it is demanded by regulatory authorities or funding agencies.

Why does measurement of cataract surgical quality matter?

Despite the availability of effective and inexpensive surgery, unoperated cataract is responsible for 35% of global blindness.[3] The cataract blindness problem is further worsened by poor surgical outcomes, particularly in low resource settings.[4]

Quality of surgery and resulting patient satisfaction are the engines that drive sustainable cataract services. Monitoring surgical quality allows clinicians and healthcare administrators to identify issues and take action to improve practice, patient outcomes and centre performance because "if you measure it, you can manage it." Outcome reporting, however, varies widely across surgical centres internationally[5] and many countries where data is available fall well below World Health Organiz ation (WHO) standards for cataract surgical outcomes.[6]

Why don't we routinely measure cataract surgical outcomes?

There are several challenges associated with routine measurement of cataract outcomes, including:

- Pressure on clinicians to generate high volume of surgical outputs
- Weak culture of quality assurance in surgical centres
- Low access to systems and tools to support continuous quality improvement
- Concern about management of complex cases
- Low rates of patient follow-up, because of the challenges getting patients to return to surgical sites several weeks following their procedure.[7]

However, these issues can be addressed by setting up a good cataract outcome monitoring and continuous quality improvement (CQI) system. This can assist practitioners and centres to identify and implement ongoing improvements in eye care delivery.

Table 1 Standards for postoperative visual acuity

	PRECOG standards for postoperative assessment (1–3 days after surgery)	WHO standards for postoperative assessment (6 weeks after surgery)
Good (6/6-6/18)	>60%	>80%
Borderline (<6/18-6/60)	<35%	<15%
Poor (<6/60)	<5%	<5%

What needs to be in place?

The essential elements of a successful outcome monitoring and continuous quality improvement (CQI) system that can assist practitioners and centres to identify and implement ongoing improvements in eye care delivery are described below.

1 Quality standards

Defining a 'good' outcome, especially with modern small-incision surgery, is the foundation of an effective CQI system. The World Health Organization (WHO) provides standards for postoperative acuity at 6 weeks[6] (see Table 1).

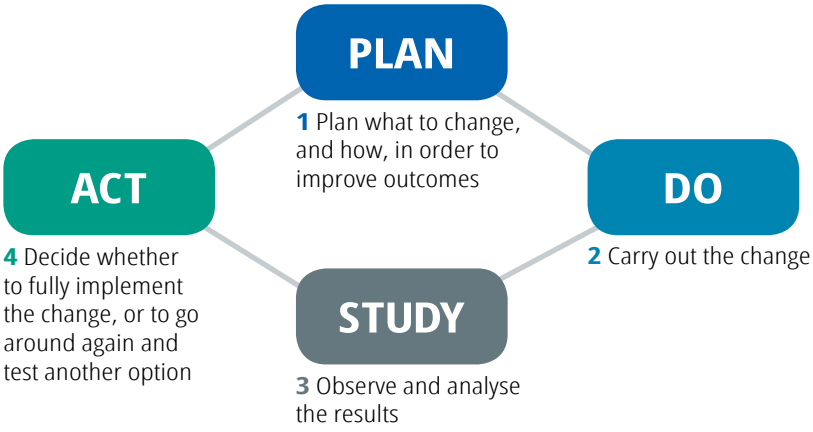
The PRECOG study[7] has demonstrated that visual acuity results the day after surgery are highly predictive of final vision. Outcomes can, therefore, also be measured 1 to 3 days after surgery. This measure of the quality of surgical outcomes is equivalent to WHO standards, but may be more convenient for many surgeons and patients, particularly in areas with low postoperative follow-up rates, (e.g., when patients have to travel long distances).

Table 1 shows the PRECOG standards for postoperative assessment 1–3 days after surgery alongside WHO standards for postoperative assessment 6 weeks after surgery.

2 Timely and routine data capture

Effective, accessible and easy-to-use data collection tools, whether electronic or on paper, improve data quality and reduce the burden of monitoring activities on clinicians and administrators.

Figure 1 The Plan-Do-Study-Act model of continuous quality improvement



3 Accessible reports

Simple, visual reports of key results encourage surgeons and administrators to engage meaningfully with outcome data.

4 Feedback and interpretation of results

Interpret the results and give supportive, non-blaming feedback to surgeons. This is an opportunity to identify potential corrective actions.

5 Ongoing improvement processes

Ongoing improvement processes make up the critical final element. High quality data and ideas regarding practice and system change can only improve outcomes if they are acted upon.

The BOOST cataract app

BOOST (Better Operative Outcomes Software Tool) is a free Android and online app that allows surgeons to easily capture key cataract outcome data. It provides simple, engaging reports and provides feedback to users about how they can improve their performance.

BOOST is an international effort, and is available in seven different languages: English, French, Spanish, Russian, Chinese, Vietnamese and Bahasa Indonesia.

It can be downloaded at the Google Play Store by searching for 'BOOST Cataract', and data can be accessed online at https://boostcataract.org/

BOOST takes users through two simple steps designed to evaluate and improve cataract surgical results.

Step 1 Benchmarking

Using BOOST, surgeons enter the uncorrected visual acuity on postoperative day 1 for 60 consecutive operated eyes. The app then tells surgeons how their results compare (anonymously) with other users globally.

Step 2 Quality improvement

The BOOST app then asks users to record the results of 20 consecutive patients with poor results (<= 6/60) at least 6 weeks after surgery. In each case, the user is prompted to choose one of three reasons for the poor result:

- Surgical complication
- The presence of another blinding condition (such as glaucoma, ARMD, DR, etc.)
- Refractive problems (wrong power IOL, lack of any IOL, etc.)

The app determines what the most common cause of poor vision is for any given user, and then makes specific recommendations to improve outcomes. For example, if the most common cause is the presence of other diseases, the app recommends specific ways to address this problem, such as a thorough preoperative examination of the eye, including the fundus, with dilation of the pupil after checking for an afferent pupillary defect.

Tips for using the app

To get the most out of the app, you need to be honest with yourself about the data you enter. Remember two things:

1 Enter data from consecutive patients, which means you need to enter *every* cataract case you do (no combined cases or paediatric cataract cases), unless the patient is known to have a problem in addition to cataract.
2 Vision should be measured and entered by someone other than the operative surgeon.

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TT Tracker app aims to improve surgical outcomes and patient care

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Director: mHealth and Innovation, Sightsavers.

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Director: Special Projects and Campaign Partnerships, International Coalition for Trachoma Control.

Trachomatous trichiasis (TT) is a painful and blinding condition in which the eyelashes turn inwards and damage the cornea. TT surgery is the remedy.

TT TRACKER

TT Tracker app reports are updated daily.

In 2017, the global trachoma elimination programme conducted more than 230,000 operations across 35 countries to treat trachomatous trichiasis (TT), the late blinding stage of trachoma.[1] TT operations are generally conducted in remote and resource-poor settings, which can make it difficult to follow up and assess surgical outcomes.

The World Health Organization recognised the challenge and convened a meeting in 2015 to discuss the development of a system to track TT patients through the steps of surgical intervention.[2] In response, Sightsavers developed an Android-based application, called the TT Tracker, which helps surgeons, assistants and supervisors to collect and analyse information about surgical outcomes and performance, and to determine when and where follow-up appointments are required.

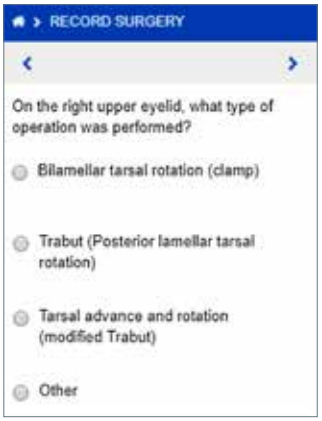
Surgical teams using the TT Tracker enter patient information into electronic forms at each stage in the patient's journey, which reduces the need to collect and file paper-based forms. The information collected includes:

- **Registration and evaluation.** Demographic information, TT diagnosis, recommended intervention
- **Surgery.** Type of operation/sutures, name of surgeon, related complications
- **Follow-up (at 24-hours, 7–14 days, and 3–6 months).** Surgical outcome assessment and actions required to address complications

Common details related to surgical provision, such as the type of suture used, are included in the predefined list of selections (adapted for each country); these are based on the International Coalition for Trachoma Control (ICTC) 'Organizing trichiasis surgical outreach' preferred practice manual.[3] Users may choose to enter additional information if the predefined list is insufficient.

All data are owned by the government and collected on password-protected devices. Surgeons are granted access to patient information within their ministry-designated working area only.

Using TT Tracker to input surgical data.



TT TRACKER

Data use and access

TT Tracker uses the information collected by surgical teams to generate the following:

Patient follow-up lists. After surgery, all patients are automatically placed on follow-up lists based on the relevant follow-up time-period; lists can be accessed by programme staff and officials approved by the Ministry of Health. Reports are electronically sent to supervisors detailing where and when follow-up must take place. Surgical outcomes are assessed during follow-up visits and are added to patient records to ensure each surgical record is complete.

Surgical performance evaluation. The TT Tracker creates performance assessments for individual surgeons so supervisors know when enhanced supervision or additional training is needed. To provide encouragement, surgeons also receive personalised emailed reports including their individual outcomes and contribution to the national elimination effort.

Timely, easy-to-access reports. The TT Tracker includes a reporting tool that analyses data automatically. Reports are updated daily and are easy to understand, allowing programme staff to use the data for decision making and to improve the programme, which in turn encourages regular use.

Rollout and potential for other uses

All national trachoma programmes are eligible to use the TT Tracker to support elimination activities; however, programmes must cover implementation costs, including training, phones and outreach. The tool has been successfully piloted in Sightsavers programmes in Nigeria and Tanzania in 2017/2018 as part of the DFID SAFE programme, followed by a country-wide roll-out in Uganda in July 2018 as part of The Queen Elizabeth Diamond Jubilee Trust's Trachoma Initiative. Full expansion is planned in 2019 in Benin, Guinea, Nigeria, Senegal, Tanzania, and Zimbabwe in the new Accelerate Trachoma Elimination Programme.

As more countries show positive results using the TT Tracker, there is potential to apply it to other surgical eye interventions or other neglected tropical diseases, further contributing to global targets for universal eye health coverage and the UN sustainable development goals.

For more information about the TT Tracker or to get in touch with the team, please visit: **www.tttracker.org/home**

References

1 WHO. WHO Alliance for the Global Elimination of Trachoma by 2020: progress report on elimination of trachoma. Wkly Epidemiol Rec 2018;93(26):369-380.

2 WHO. Informal consultation on a tracking system for patients with trachomatous trichiasis. 2015. **bit.ly/WHO-TT**

3 The International Coalition for Trachoma Control (icTc), Organizing trichiasis surgical outreach, April 2015 **http://bit.ly/ttoutreach**

Onchocerciasis: the beginning of the end?

Adrian Hopkins
Consultant.
Former Director of the Mectizan Donation Programme.
Gravesend, UK.

With a concerted effort, onchocerciasis could be the first blinding disease to be eradicated.

ADRIAN HOPKINS

Community distribution of ivermectin (Mectizan®). BURUNDI

Onchocerciasis causes skin and eye disease, visual impairment and neurological problems. It is mostly found in Africa, but also in Latin America and Yemen. The common name, 'river blindness,' gives a good indication where the disease can be found: the vector of the parasite, a small black fly of the *Simulum* species, breeds in rivers where there is turbulence in the water, such as rapids, or where the flow is disturbed by overhanging vegetation.

The medicine first used to treat onchocerciasis was diethylcarbamazine. Unfortunately, it was associated with severe inflammation and deterioration of vision and so was eventually contraindicated.

In the 1970s, efforts were undertaken to prevent onchocerciasis by controlling the black fly that spread the disease. This was done by spraying larvicide over black fly breeding sites, which killed the larvae before they could develop into adult flies. This proved to be successful at stopping transmission and became the basis of the Onchocerciasis Control Programme (OCP) in 11 countries in West Africa.

A paradigm shift in the management of onchocerciasis occurred when MSD (known as Merck & Co Inc. in the USA and Canada) announced that they would donate a new drug, Mectizan (ivermectin MSD), that was safe to use and had been shown to be effective.

In October 1987, MSD agreed to provide the drug free of charge to as many people as needed, for as long as it was needed. This led to the expansion of control efforts to other countries in Africa, Latin America and Yemen.

At the end of 1995, the African Programme for Onchocerciasis Control (APOC) was created. New mapping procedures were developed and mass drug administration (MDA) with ivermectin was carried out in heavily infected areas. A novel approach to distribution, known as community-directed treatment with ivermectin (CDTI), put communities in charge of deciding how and when distribution would take place. APOC was very successful as a control programme and was even expanded into countries that were experiencing conflict.

A further paradigm shift occurred when research showed that ivermectin alone could interrupt the transmission of infection in Africa. This had already been demonstrated in Latin America, where the disease occurs in small, isolated areas, or foci.

Interruption of transmission is very important if onchocerciasis is to be eliminated rather than controlled as a public health problem.

What do we need to do to eliminate onchocerciasis globally?

Countries are being urged to do the following:

- Set up national committees as part of their neglected tropical disease (NTD) programmes to review each focus of infection in detail and decide on the best strategy for individual foci.
- Expand mapping to include all potential areas of disease, not just heavily infected areas, to decide where treatment is needed. This will be done using a new mapping technique called onchocerciasis elimination mapping (OEM).
- Build laboratory capacity and implement monitoring and evaluation through epidemiological and entomological surveys.
- Continue with advocacy as the disease gradually disappears and is no longer a major issue in endemic countries.

Alternative, or additional, strategies must be explored:

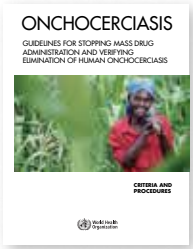
- There is a need to evaluate the best use of ivermectin, e.g., conducting MDA twice (or even more times) per year.
- New drugs, especially those that can kill the adult parasite worm, would greatly speed up elimination
- Vector control using insecticides or, more. appropriately, removing vegetation from river banks, can increase the impact of MDA.

Many countries in Africa may be able to stop treatment by 2020. Can treatment be stopped everywhere by 2025? With concerted efforts, the answer could be yes; however, if the effort is not made, recurrence of the disease becomes a very real possibility.

Reference

http://atlas.iapb.org/vision-trends/onchocerciasis/

Useful websites



1 For technical guidance Onchocerciasis: Guidelines for stopping mass drug administration and verifying elimination of human onchocerciasis **http://apps.who.int/iris/bitstream/handle/10665/204180/9789241510011_eng.pdf**

2 For advocacy River Blindness: The beginning of the end **https://mectizan.org/wp-content/uploads/2018/11/Onchocerciasis-Advocacy-Document.pdf**

3 For details on Mectizan: **https://mectizan.org**

Test your knowledge and understanding

This quiz is designed to help you test your own understanding of the concepts covered in this issue, and to reflect on what you have learnt.

ARAVIND EYE CARE SYSTEM

Measuring blood pressure in patients admitted for cataract surgery. INDIA

We hope that you will also discuss the questions with your colleagues and other members of the eye care team, perhaps in a journal club. To complete the activities online – and get instant feedback – please visit **www.cehjournal.org**

Tick ALL that are TRUE

Question 1

When dealing with a patient with uveitis and cataract:

- ☐ **a.** It does not matter if the uveitis is settled pre-operatively, so long as you give plenty of steroids postoperatively
- ☐ **b.** Manipulating the iris to break synechiae or stretch a small pupil will increase the amount of postoperative inflammation
- ☐ **c.** There is not much difference in the inflammatory response among the various types of IOL
- ☐ **d.** It is a good idea to combine cataract surgery and glaucoma surgery if the patient has glaucoma

Question 2

In patients with diabetes who have cataract:

- ☐ **a.** If the patient's sugar level is high on the day of surgery, it is better to delay the operation until their control is better
- ☐ **b.** Postoperative capsular contraction can limit the view of the retina after surgery; therefore, a large capsulorhexis is advisable
- ☐ **c.** Cataract starts younger in patients who have diabetes
- ☐ **d.** Macular oedema is much more common after cataract surgery in patients who have diabetes

Question 3

If managing a patient with Fuch's endothelial corneal dystrophy:

- ☐ **a.** It is quite easy to miss Fuch's endothelial corneal dystrophy in clinic when listing a patient for cataract surgery
- ☐ **b.** Cohesive viscoelastics provide the best protection for the endothelium
- ☐ **c.** If you don't have a specular microscope to count endothelial cells but can do pachymetry, you can use central corneal thickness as a marker of endothelial health
- ☐ **d.** If you have access to phacoemulsification, then this is the best technique, even if you are not very experienced with it

Question 4

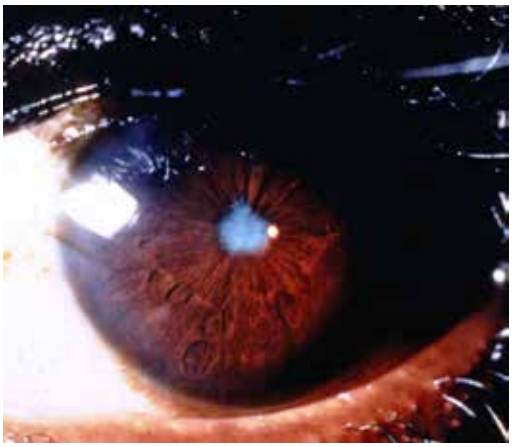
When operating on a patient with a small pupil:

- ☐ **a.** Dilating drops should be put in 4–6 hours pre-operatively to give them maximum time to work
- ☐ **b.** It is important to identify the cause of the small pupil pre-operatively
- ☐ **c.** The options for managing small pupils are expensive, so additional charges will be required
- ☐ **d.** If the pupil is dilated surgically, it may never return to its previous shape or size and the patient should be warned about this

ANSWERS

1. a. False. It is essential to control the pre-operative inflammation before operating – preferably for 3 months or more. b. True. c. False. Different IOL materials promote varying levels of fibrotic response. d. False. In uveitis, combined surgery gives a very low success rate for the trabeculectomy.
2. a. False. Poor diabetic control has long term implications but will not affect the outcome of surgery. b. True. c. True. d. True.
3. a. True. b. False. Dispersive viscoelastics spread themselves onto the endothelium creating a protective coating. c. True. d. False. Effective surgery with the technique you are most familiar with is likely to minimise endothelial damage.
4. a. False. Dilation starts to wear off after a few hour. Starting dilating drops one prior to surgery is probably optimal. b. True. c. False. Bimanual pupil stretching should be adequate in most cases and involves no extra cost to the hospital other than slightly longer surgical time. d. True.

Picture quiz



A 40-year-old man presents with poor vision. The left eye has phthisis bulbi with no light perception. The right eye has perception of light with accurate projection of light.

See picture above.

Question 1

What do you see on examination?

Question 2

How could this have been prevented?

Question 3

What are the principles involved in management?

ANSWERS

1 The cornea appears clear. The pupil is small and irregular. The pupil is white, probably due to a fibrotic membrane; however, it may also be due to lens opacity. From this picture it is not possible to assess the depth of the anterior chamber, but if the pupil is occluded and aqueous cannot pass into the anterior chamber then the peripheral iris may be pushed forward.

2. The original problem is almost certainly iritis which has caused adhesions between iris and lens, also known as posterior synechiae. The adhesions could have been prevented if the pupil had been dilated at the original episode of iritis and kept dilated until the iritis resolved.

3. This is a complicated case to manage. It is the patient's only functioning eye. The patient can see light with accurate projection, which indicates that the optic nerve and retina are functioning.

The principles involved in management are:

- Check the intraocular pressure and, if raised, lower it either medically or with a laser or peripheral iridotomy
- Break the adhesions causing the small irregular pupil; mydriatics can be tried first. If this does not work, then surgery will be indicated.
- When the pupil adhesions have been broken and any membrane removed the lens can be assessed. If clear, no further surgical treatment is indicated; if there is a cataract, then this will have to be removed. Surgical management of the small irregular pupil and removal of a cataract (if present) is difficult; it should only be undertaken by an ophthalmologist with experience in managing patients with complicated cataract.

Obituaries

IAPBS

Dr Uduak Udom of Nigeria, the World Council of Optometry's immediate past president and a friend of the *Community Eye Health Journal*, has passed away after a long and courageous battle with illness. Read more about her remarkable career here: **http://bit.ly/UduakUdom**

CBM

Dr Frank Green (UK) is remembered for his work providing ophthalmology services to refugees in Myanmar and Thailand. He performed over 20,000 cataract operations and trained selected Karen refugees to perform cataract surgery. Read more here: **http://bit.ly/DrFrankGreen**

Useful resources

The Eye Book: an Illustrated Guide for Patients. Orbis has produced a book to support doctors, nurses and allied health personnel when they discuss eye diseases and conditions with patients, parents, family members and caregivers. Available for free download from Cybersight at **https://cybersight.org/portfolio/the-eye-book-an-illustrated-guide-for-patients/**

ORBIS/CYBERSIGHT

Courses

MSc Public Health for Eye Care, London School of Hygiene & Tropical Medicine, London, UK

Fully funded scholarships are available for Commonwealth country nationals. For more information visit **www.lshtm.ac.uk/study/masters/mscphec.html** or email **romulo.fabunan@lsthm.ac.uk**

Small Incision Cataract Surgery Training at Lions Medical Training Centre in Nairobi, Kenya

Courses begin every six weeks and cost US $1,000 for training and approximately US $1,000 for accommodation. Email **training@lionsloresho.org** or call/message +254 728 970 601 or +254 733 619 191.

Free online courses

The ICEH Open Education for eye care programme offers a series of online courses in key topics in public health eye care. All the courses are free to access. More free courses coming! Certification also available. For more information visit **http://iceh.lshtm.ac.uk/oer/**

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Next issue

BRIEN HOLDEN VISION INSTITUTE

The next issue of the *Community Eye Health Journal* is on the theme **Myopia**

Key messages: Complicated cataract surgery

Initial consultation

ARAVIND EYE CARE SYSTEMS

- Identify patients in whom cataract surgery will be complicated or difficult; this avoids unwelcome surprises in the operating theatre
- Manage patients' expectations. Explain what to expect after surgery (in terms of the visual outcome and the potential need for further treatment) and obtain informed consent

Be prepared

ARAVIND EYE CARE SYSTEMS

- Anticipate potential difficulties
- Check that all equipment, instruments and consumables are sterilised and available
- Brief the surgical team thoroughly

After surgery

The success or failure of the operation may depend on good postoperative care.

ARAVIND EYE CARE SYSTEMS

- Ensure that inflammation is under control
- Explain to patients how important it is that they take their postoperative medication and come back for follow-up visits

Ocular emergencies in the South Asia region

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Noopur Gupta
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Praveen Vashist
Professor of Community Ophthalmology: Dr Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi

Eye care providers at different levels in South Asia must be able to diagnose, manage, initiate first-aid and refer during an ocular emergency.

Ocular emergencies are an important cause of morbidity in South Asia and studying their spectrum and presentation is vital for developing local preventive and therapeutic programmes. Primary care providers must be able to diagnose, manage, initiate first-aid, or refer, as any delay in treatment during an ocular emergency can result in permanent loss of vision.[1]

Ocular trauma

Any form of trauma is an emergency and prompt treatment can arrest complications and long-term morbidity (Figure 1). The prognosis of any injury is commonly made worse by delayed presentation and use of inappropriate, untested products and traditional medicines.[2] Health promotion interventions in injury prevention include raising awareness and actively involving the community. Workplace trauma can be prevented through occupational health laws which educate workers and promote the use of protective eyewear. Children are often victims of ocular trauma, so health education in schools is very important.

Ocular trauma can be classified into
- Penetrating injuries
- Blunt injuries
- Chemical injuries
- Ocular burns

Penetrating injuries

Open globe injuries are caused by sharp objects in which there is full thickness wound in the eyewall. The patient may present with a sudden loss of vision, pain, watering and an inability to open the eye. Visual acuity should be measured for each patient. Surgical closure is necessary in case of open globe injuries in order to minimise the risk of further infection. Intra-ocular foreign bodies, if present, should be removed; this requires specialist facilities and surgery.

Blunt injuries

Closed-globe injuries are caused by blunt objects, where there is no full thickness wound of the eyewall comprising sclera and cornea.

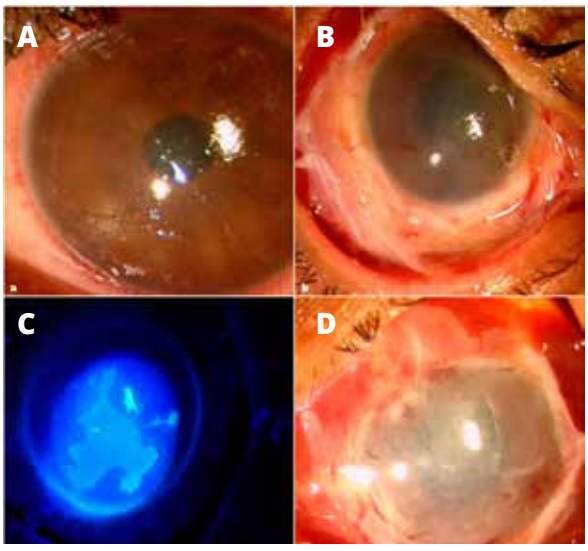
The patient may present with loss of vision, pain and inability to open the eye. Visual acuity, pupillary reactions and the posterior segment should be evaluated in all cases. The management will depend on the severity of the injury. With conservative treatment, a simple hyphema will usually reabsorb after a few days.

R P CENTRE/ AIIMS

Figure 1 Mechanical injuries

Chemical injuries

Chemical injuries may present in different ways, depending on the nature of the chemical agent, its concentration and volume, and the duration of exposure.[3] Both acids and alkalis can cause eye injuries. Many occur in men who are at risk of exposure to chemicals such as lime (calcium hydroxide), ammonia, sodium or magnesium hydroxide in the workplace (Figure 2).



R P CENTRE/ AIIMS

Figure 2 Chemical injuries of the ocular surface. **A.** Epithelial defect following acute chemical injury. **B.** Amniotic membrane transplantation **C.** Epithelial defect as seen on slit lamp under cobalt filter after fluorescein staining **D.** Amniotic membrane transplantation.

The first step in the management of chemical injuries is immediate and meticulous irrigation of the eye. This is done by everting the eyelids and flushing with ringer lactate or normal saline until the pH of the ocular surface is neutralised. Timely treatment that includes topical antibiotics, cycloplegics, topical steroids, topical sodium ascorbate & citrate 10%, oral doxycycline, oral ascorbate and tear substitutes must be instituted.

Ocular burns

Ocular damage from thermal burns can result from contact with boiling liquid, molten metal, flames, gasoline explosions, steam or hot tar. Firecrackers can cause combined chemical and thermal burns on the ocular surface.

The management of ocular burns depends on the type of injury. However immediate cleaning and irrigation with normal saline or clean water is an important first aid measure.

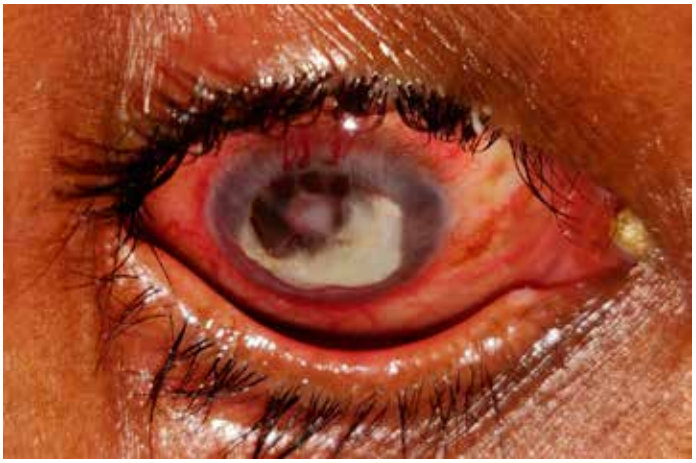
Corneal Ulcer

Corneal ulcers are common in the South Asian region, especially in countries with rural and developing economies.[4] A corneal ulcer is defined as a corneal epithelial defect with infiltration of the deeper stroma, most commonly caused by infection. Viral ulcers arise spontaneously on a previously intact epithelium, while bacterial and fungal ulcers occur after a traumatic break in the corneal epithelium. Fungal ulcers typically start after an injury with organic matter.

Figure 3 Fungal corneal ulcer

R P CENTRE/ AIIMS

Figure 4 A penetrating corneal ulcer with sloughing of the cornea and uveal tissue show requiring urgent keratoplasty



R P CENTRE/ AIIMS

Patients with a corneal ulcer present with pain in the eyes, foreign body sensation, photophobia, discharge, watering and blurred vision. It is important to elicit a proper history and sequence of events. Patients should be asked about ocular medications, especially the use of corticosteroids, previous eye surgery, ocular disease and systemic illness.

On examination, the eye will typically look congested with a white corneal lesion indicating stromal infiltration (Figure 3). A corneal scraping can be taken and sent for Gram and KOH staining along with bacterial and fungal culture and sensitivities, since determining the infectious aetiology is important to guide future treatment.

Immediate initiation of a topical antibiotic followed by prompt referral to a higher centre is necessary. Fortified antibiotics such as tobramycin and a cephalosporin or vancomycin are appropriate for severe, deep, or central corneal ulcers. Fungal ulcers are treated with topical natamycin 5% or topical voriconazole 1% eyedrops. Supportive treatment like cycloplegics, oral analgesics and antiglaucoma agents maybe required. Close follow-up is essential for all corneal ulcers as non-resolving ulcers or penetrating ulcers (Figure 4) may require an urgent therapeutic keratoplasty to debulk the cornea of infectious tissue and/or restore the integrity of the eye (Figure 5).

Prevention

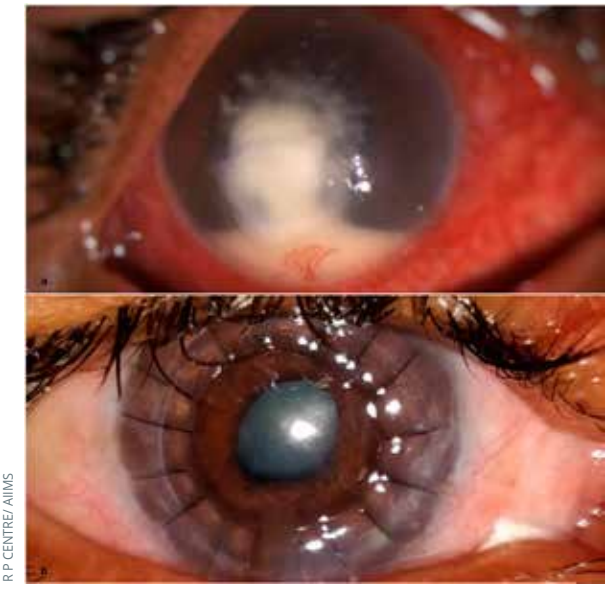
Agricultural workers can use protective goggles that can aid in prevention of corneal ulcers. Community awareness of risk factors and effects of using traditional medicine can help in minimising severe consequences. Early recognition of symptoms, institution of appropriate treatment by the community health workers or ophthalmologists and prompt referral where necessary are critical in prevention of corneal ulcers.

Acute glaucoma

Acute angle-closure glaucoma is caused by the sudden closure of the anterior chamber angle. This leads to inadequate drainage of the aqueous humour and a subsequent elevation in intraocular pressure (IOP) which can lead to optic nerve damage. It is more common in the South East Asia region and if not recognised and treated on time can cause blindness within hours.

Patients present with severe ocular pain, decreased vision, nausea and vomiting, intermittent blurring of vision with halos, and headache. Ocular examination shows conjunctival infection, corneal oedema, a mid-dilated pupil that does not react well to light, shallow anterior chamber and decreased vision. IOP usually ranges from 40 to 90 mm Hg.

Once acute angle closure is suspected, IOP is lowered with oral acetazolamide and topical timolol, pilocarpine, and apraclonidine, while monitoring changes to the angle and optic nerve head. Hyperosmotic agents such as oral glycerol or intravenous mannitol are effective in lowering IOP during an emergency. Once IOP is controlled laser iridotomy is performed in both the affected eye and the fellow eye as well to prevent acute attacks. Prompt, appropriate diagnosis, aggressive treatment and management are necessary to prevent, or minimise, significant ocular morbidity in patients with angle closure glaucoma.



R.P. CENTRE/ AIIMS

Figure 5 A. Fungal corneal ulcer with hypopyon **B.** Following therapeutic keratoplasty for the ulcer

Acute loss of vision

Acute loss of vision in a white eye can occur due to central retinal artery occlusion (CRAO), retinal detachment, optic neuritis (Table 1). Immediate evaluation and referral to a tertiary care centre is important. Risk factors for CRAO include old age, being male, smoking, hypertension, diabetes, cardiovascular diseases and coagulopathies. Control of modifiable risk factors via health education and health promotion is the primary prevention of CRAO.

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Table 1 Eye emergencies and care at different levels

Eye emergency	Primary level	Secondary Level	Tertiary level
Penetrating injury	• History and examination • Injection tetanus toxoid • Start oral antibiotics • Shield/protect the eye • Refer to higher centre	• History and examination • Admission and urgent primary surgical repair under general anaesthesia • Refer to higher centre if facility is not available	• Surgical repair • Intraocular foreign body removal by specialist • Post-operative rehabilitation
Chemical injury	• History • Irrigation of the eye ++++ • Urgent referral to higher centre	• History + examination • Irrigation of the eye ++++ • Remove any particulate matter • Start topical antibiotics, cycloplegics, and oral ascorbate • Urgent referral to higher centre if indicated	• Management depends on the severity and type of chemical injury. Severe alkaline burns may require long-term medical and surgical treatment
Corneal ulcer	• History and examination • Topical antibiotics e.g. eye ointment chloramphenicol 1% • **NEVER START STEROIDS** • **Stay away from traditional eye medicines** • **Refer** to a higher centre	• History + examination • Confirm diagnosis of corneal ulcer • Take corneal scraping for KOH/ Gram smear to identify organism • Admit the patient if facility is available, if there is a threat to vision and to ensure treatment compliance and follow-up **Refer to a tertiary ophthalmic centre if:** • the patient is a child • there is impending or actual penetration • it is in the only functional eye • no facility for corneal scraping **TREATMENT:** • *NO FUNGAL HYPHAE-* • Start topical cefazolin 5% and tobramycin 1.3% hourly • If no improvement after three days **REFER** • *FUNGAL HYPHAE seen –* • Start topical natamycin 5% • If no improvement after three days **REFER**	• History + examination • Confirm diagnosis and classification • Take corneal scraping for smear and culture for antibiotic and anti-fungal sensitivity • Admit if indicated • Initiate empirical treatment and then targeted treatment based on microbiology workup • Systemic antifungals are recommended in fungal ulcers, which are: large and deep, associated hypopyon, perforating, or have scleral involvement • Systemic antibiotics are recommended in bacterial ulcers if there is scleral involvement, associated endophthalmitis or perforation • If responding to treatment, taper frequency of drops and follow up • If no response to treatment or perforation, consider: **SURGICAL OPTIONS** • Surgical debridement • Tarsorrhaphy • Patch grafts • Conjunctival flaps • Penetrating/lamellar keratoplasty

Eye emergency	Primary level	Secondary Level	Tertiary level
Endophthalmitis • History of intraocular surgery or trauma • Redness, pain, watering, lid edema • Decreased visual acuity Hypopyon may be present in most cases.	• Urgent referral to tertiary centre	• Urgent referral to tertiary centre • Start topical and oral antibiotics (fluoroquinolones)	• Vitreous tap • Systemic antibiotics • Intravitreal antibiotics • *Vancomycin 1.0 mg/0.1 mL* • *Ceftazidime 2.25 mg/0.1 mL* • *Amphotericin B 5-10 ug/0.1 mL* (if fungal suspected) • Corticosteroids (to modulate the ongoing host inflammatory response), avoid when fungal is suspected • Pars plana vitrectomy if no response to treatment
Orbital cellulitis • Fever • Lid oedema • Proptosis • Painful ocular movements • Decreased visual acuity	• Urgent referral to tertiary centre • Start oral antibiotics	• Urgent referral to tertiary centre • Start IV / IM or oral antibiotics	• Admission • Blood culture and routine blood tests • Orbital imaging will reveal pus pockets in the orbit / infection in the paranasal sinuses • Intravenous broad-spectrum antibiotics for initial seven days followed by shifting to oral antibiotics for seven-14 days. • I.V. Vancomycin 40 mg/kg/day in 2-3 divided doses per day • I.V. Ceftriaxone 100 mg/kg/day in 2 divided doses per day • I.V. metronidazole 30 mg/kg/day in 3 divided doses per day (in case of suspected anaerobic organism) • Occasionally surgical drainage of orbital abscess by ophthalmologist and surgical drainage of sinuses by ENT specialist
Acute glaucoma • Sudden onset, unilateral ocular pain • Headache • Coloured halos • Decreased visual acuity • Nausea and vomiting	• Immediate recognition • Check intraocular pressure digitally (eye will be stony hard) or with *TONOPEN* • Give oral acetazolamide 500 mg stat • Urgent referral to higher centre	• Check intraocular pressure • Oral acetazolamide 500 mg • Topical beta blocker (timolol) • Admission if facility available • Hyperosmotic agents (intravenous mannitol or oral glycerine) • Laser PI if available	• Check intraocular pressure • Oral acetazolamide 500 mg • Topical beta blocker (timolol) and / or 2% piolocarpine • Hyperosmotic agents (intravenous mannitol or oral glycerine) • Gonioscopy to check angle • Laser PI • Consider glaucoma filtering surgery once acute stage is managed
Optic neuritis • Unilateral visual loss • Pain with ocular movements • Afferent pupillary defect • Colour vision deficiency • Disc may be normal (retrobulbar neuritis) or swollen (papillitis) • Visual field loss	• Urgent referral to tertiary centre	• Urgent referral to tertiary centre	• Confirm diagnosis • Complete blood investigations. • Start ***intravenous high-dose methylprednisolone for three days followed by 11 days of oral 1 mg/kg/day prednisone*** after tuberculosis and malignancy is ruled out. • Neurology referral with MRI brain
Retinal detachment • Sudden onset, painless loss of vision • Flash of light, floaters and curtain falling in front of eye	• Urgent referral to tertiary centre	• Perform dilated fundus examination/fundus camera • Urgent referral to tertiary centre	• Immediate surgical management by a vitreo-retina specialist • Screening of the other eye for any predisposing lesions and prompt laser.

How much trachomatous trichiasis is there? A guide to calculating district-level estimates

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Estimating the number of people with trachomatous trichiasis allows managers to plan surgical services and obtain the resources needed to eliminate this painful condition.

KATRINA SOMMERS, THE CARTER CENTRE. COURTESY OF IAPB. CC BY-NC-SA 2.0

Patients who have undergone trachomatous trichiasis surgery. SOUTH SUDAN

In some people living in trachoma-endemic areas, repeated conjunctival *Chlamydia trachomatis* infection eventually leads to trachomatous trichiasis (TT), in which one or more eyelashes are misdirected so that they rub on the eyeball.[1,2] Untreated, this can scar the cornea and result in permanent blindness. Estimating the likely number of people with TT helps programme managers to plan surgical services and secure resources.[3,4] Recent work to complete high-quality baseline mapping of suspected trachoma-endemic populations worldwide[5,6] and to standardise the systems and methodologies of trachoma impact surveys, pre-validation surveillance surveys, and TT-only surveys[7–10] has facilitated production of more accurate estimates of the number of people with TT.[11,12]

This paper, intended for programme managers and their supporters, explains the concepts involved in estimating TT prevalence and discusses programmatic applications of that information. We hope it will help these stakeholders to use their TT data with greater confidence.

1. What does prevalence mean?

The *prevalence* of a disease is the percentage of people in a defined population who are affected by that disease at a particular time. In this definition, it is important to clearly identify the *defined population*. The prevalence of TT can be estimated for a single community,[13] a single administrative division of a country,[14] or a whole country.[15] At each of these levels, prevalence could be estimated in (for example) people of all ages,[16] people aged ≥15 years,[17] women aged ≥15 years,[18] or some other subset of the population, such as indigenous inhabitants,[19] so it is important to be clear on the group being studied.

2. At what administrative level are TT prevalence estimates usually generated?

For trachoma elimination purposes, the World Health Organization (WHO) defines districts as "the normal administrative unit for health care management," which "for purposes of clarification, consists of a population unit between 100,000 and 250,000 persons".[20] Although surveys at baseline may be conducted at larger-than-district-level in order to start the programme,[20–23] it is currently recommended that impact, pre-validation surveillance and TT-only surveys are done at district level. In the real world, the term *district* has different meanings in different contexts. Because of this, and because the administrative level surveyed may change from one round of surveys to the next, we will subsequently refer here instead to *evaluation units* (EUs), a generic term for the population unit surveyed, regardless of size – even though we used 'district-level' (for readability) in the title of this article.

Regardless of the administrative level at which EUs are framed, data should be interpreted and applied at that same level; in other words, local data should inform local action.

3. What data are used to generate TT prevalence estimates?

To estimate TT prevalence, population-based surveys are recommended.[24] Standard trachoma baseline, impact, pre-validation surveillance and TT-only surveys are all population-based surveys. These all employ sampling, in which a small proportion of EU residents

Continues overleaf ➤

are selected for examination, using a random or quasi-random sampling technique, with data on individuals examined considered to be representative of the EU population overall.

In trachoma surveys, the sampling strategy used is often two-stage cluster sampling.[24] The first stage involves selecting 20–30 communities (*first-stage clusters*) from the set of all communities in the EU. The second stage, undertaken within each selected community, involves selecting a fixed number of households (*second-stage clusters*, often grouped within a single compact segment[25,26]) from the set of all households in the community. (In *compact segment* sampling, a sketch map is drawn of the sampled first-stage cluster, and the area then divided into sub-clusters or segments containing approximately equal numbers of households. One segment is selected by random draw.) All qualifying individuals living in selected households are asked to participate (in compact segment sampling, all residents of all households in the compact segment are asked to participate[27]), and both eyes of consenting individuals are examined by certified trachoma graders.[5,10]

A *person with trichiasis* is defined as someone in whom, in at least one eye, one or more eyelashes touch the eyeball or there is evidence of recent removal of in-turned eyelashes. Although determining whether eyelashes that have been removed were in-turned is difficult, this may be very important: in Fiji, for example, many adults practice eyelash epilation in the absence of trichiasis.[28]

4. How are survey data processed to generate a TT prevalence estimate?

Before any calculations are performed, data are screened for possible errors, such as missing data from some included communities, inclusion of data from communities lying outside the EU, or missing data from particular demographic subsets. Best practice[29] calls for data to be cleaned and analysed by an objective data manager who works in collaboration with, but at arm's length from, the health ministry, employing standardised methods. Outputs are checked and approved by the responsible health ministry.[5,6] Then if, for example, 2,000 people aged ≥15 years living in the EU were examined, and 10 of them had TT, the raw TT prevalence in ≥15-year-olds would be 0.5%. (In this example, the calculation is: Prevalence = (10/2,000) × 100 = 0.5%. The number 10 here is referred to as the numerator, and 2,000 is the denominator.)

Such an estimate may not represent the true EU-level prevalence in ≥15-year-olds, for two reasons. First, it is rare that everyone resident in selected households is examined: women and older adults are both more likely to be examined in house-to-house surveys, and more likely to have trichiasis, than men and younger adults, respectively. Second, the number of ≥15-year-olds examined in a set number of households (say, n households) in each community varies. Communities in which a greater number of ≥15-year-olds are examined should not contribute more weight to the EU-level prevalence.

To compensate, partially, for the first problem (unbalanced recruitment of different age and gender groups), standard trachoma survey analyses adjust the first-stage cluster data by gender and age in five-year age bands. This can be conceptualised as filling in missing data from individuals who were resident in selected households but not examined, using the assumption that their risk of trichiasis was similar to that of residents of similar age and gender who were examined. To compensate for the second problem (varying numbers of individuals examined per cluster), the age- and gender-adjusted first-stage cluster-level TT percentages are averaged to generate the EU-level TT prevalence. This gives equal weight to each of the first-stage clusters, as if the same number of ≥15-year-olds had been examined in each one.

5. How accurate are TT prevalence estimates generated from cluster-sampled surveys?

Estimates generated through sampling are subject to two types of error: bias and chance. Bias is present if the people included in the sample are systematically different to the EU population as a whole: under-representation of adults with jobs that result in absence on the day of the survey, for example. Gender- and age-adjustment, as described above, attempts to partially correct for this problem, but cannot fully compensate for it. (Biases cannot be quantified, and no amount of statistical manipulation should be considered to completely remove their effect.)

Chance affects prevalence estimates through sampling variation: if a different sample of 2000 ≥15-year-olds living in the EU had been examined, a different prevalence estimate might have been generated. The chance-induced uncertainty of an estimate produced through sampling can be quantified: it is expressed as a confidence interval. A 95% confidence interval suggests that, based on the observed data, if surveys using the same methodology were repeated multiple times in the EU, in 95% of instances the prevalence estimate would fall between the confidence interval's lower and upper bounds. Other factors being equal, larger sample sizes will produce narrower confidence intervals.

6. Can data from house-to-house case searches be used to generate a TT prevalence estimate instead?

In some programmes, TT case-finding is undertaken through house-to-house searches.[30] If a very high proportion of households in a very high proportion of the EU's communities are visited, with examination undertaken by appropriately trained examiners, such an exercise could provide a better estimate of TT prevalence than a cluster-sampled survey. (Thinking statistically: by trying to examine everyone, chance is removed, though it is possible that bias is not.)

7. What are known and unknown cases of TT, and why is the distinction important?

The trichiasis prevalence threshold for "elimination of trachoma as a public health problem" is a prevalence of TT unknown to the health system in ≥15-year-olds of <0.2%.[31] Known cases are people with trichiasis in eyes that have already had surgery for trichiasis,

for which surgery has been refused, or for which a surgical date has been agreed. (An aide-memoire for this is: "recurrences, refusals and those already referred".) In standard trachoma surveys,[10,32] when an eye is diagnosed as having trichiasis, the subject is asked if a health worker has ever recommended surgery or epilation for that eye.[33] This allows accurate determination of the numerator for estimating the prevalence of TT unknown to the health system, as included in Tropical Data's expanded trichiasis report (**http://tropicaldata.knowledgeowl.com/help/demo-project—expanded-trichiasis-report**).

8. What is postoperative TT, and why is this important?

Even when surgeons are highly skilled, by 12 months after surgery, at least 8–10% of patients again have TT.[34,35] Some of this postoperative TT may be due to under-correction and some to further progression of the underlying scarring processes; the term postoperative TT avoids the need to blame or absolve the surgeon, by simply noting that TT is present after an operation has been performed.[36] Postoperative TT is probably not optimally managed by repeating the same procedure that was used to treat primary TT, and should be managed by the most experienced trichiasis surgeon or eye specialist available.[36,37] All programmes should have a plan for managing postoperative TT, so the expanded trichiasis report includes specific information to assist.

It's important to note that standard trachoma surveys do not provide information on how often TT surgery is successful, because individuals who have been successfully managed will not be recorded as being any different to those who have never had TT.

9. Why does the expanded trichiasis report also provide data on trichiasis + TS (trichiasis plus trachomatous scarring)?

Not all trichiasis is caused by trachoma.[38] The global trachoma programme is currently trying to better understand how to distinguish trachomatous from non-trachomatous trichiasis. As part of this effort, when an eye is diagnosed as having trichiasis, standard trachoma survey systems prompt the examiner to assess the conjunctiva of that eye for the presence or absence of trachomatous scarring (TS); when the eyelid cannot be everted, the eye is presumed to have TS.[6] Generation of these data was recommended by the 2nd Global Scientific Meeting on TT.[36]

10. How does the TT prevalence estimate relate to the number of people who need surgery?

TT prevalence is useful at EU level for determining whether the TT prevalence criterion for elimination as a public health problem has been reached; if it has not, public health-level TT surgery services, including active case finding, are recommended. For service planning, the number of prevalent cases should be determined by multiplying the TT prevalence in ≥15-year-olds by the number of resident ≥15-year-olds in the EU. It is important to remember that the number of prevalent cases is just an estimate. Programmes should aim to cover the entire EU with case finding and TT management; this may identify considerably more or considerably fewer people with TT than indicated by the estimate.

11. How is the presence of TT in both eyes accounted for?

In an individual with TT, one or both eyes may need management. When planning surgical services, a requirement to operate on two eyes rather than one increases (in varying proportions) requirements for selected consumables and operating theatre time. The expanded trichiasis report uses data on the proportion of survey subjects who had bilateral disease to provide an estimate of the number of eyes, as well as the number of people, with TT.

12. Should my estimate of the number of prevalent cases take into account the number of people managed for TT since the most recent prevalence survey?

No: not unless those people were managed within a few weeks of the survey and no further time has passed. As months and years elapse after a survey, new (incident) cases of TT develop; determining that the TT prevalence is below the TT prevalence threshold for elimination of trachoma as a public health problem[31] almost always requires a formal prevalence estimate. It's also critical to remember that after the TT prevalence criterion for elimination[31] has been achieved, the need to provide surgical services does not disappear: programmes should expect incident cases to continue to occur for many years. This is the rationale for the inclusion of "written evidence that the health system is able to identify and manage incident TT cases, using defined strategies, with evidence of appropriate financial resources to implement those strategies"[20] as a criterion for trachoma elimination.[31]

13. Why aren't we talking about the TT backlog or the ultimate intervention goal?

Each of these terms has been used in different ways by different stakeholders, such that their usefulness as labels has been completely eroded. We do not recommend that these terms be used.

14. Can we eliminate TT by 2020?

Yes. Unlike active trachoma – where the dynamics of *C. trachomatis* transmission[39,40] are fundamental to programme impact, and accelerated intervention, such as biannual antibiotic mass drug administration, has not been shown to make a programmatically significant difference[41] – the rate of decline in TT prevalence is determined by the resources invested. More systematic TT case-finding – plus good access to trained, certified, resourced, and appropriately motivated surgeons and surgical teams – will lead to faster reductions in the numbers of prevalent cases. That is not to say that speed of service delivery is the only important consideration: quality[42,43] is also paramount.

Vision loss from TT is avoidable. Together, we must do everything we can to consign it to history.

The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated

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