CATARACT

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INTRODUCTION

Cataracts are the commonest reversible cause of blindness in the developed world. They occupy more than 75 percent of my surgical time and represent more than 90 percent of the elective cases passing through the ward.

They occur when opacities develop within the natural lens of the eye. They are mostly age related, though they can be accelerated by diabetes mellitus or previous eye surgery. They are a common complication of all kinds of ocular disease, most notably uveitis.

The single other common cause of cataract is trauma, either direct injury to the lens or blunt injury to the eye.

Long term treatment with some drugs, such as systemic steroids, can produce cataracts.

The symptoms and management for all these types of cataract are similar. The management of congenital cataracts differs and will not be part of this discussion.

SYMPTOMS AND SIGNS

Patients with cataracts notice a gradual visual blur and they often say that their vision is variable, being worse in bright sunlight and when driving at night. The two reasons for this are diffraction of light by the lens opacities and closing down of the pupil onto a central lens opacity reducing the amount of light reaching the retina.

Gradual visual blur
Variable vision, worse in bright sun
Rapid alteration in refraction
Distortion
Haloes
Monocular diplopia
Apparent worsening of glaucoma field defects

Table 1 – Symptoms

Cortical lens opacities classically resemble the spokes of a wheel and may produce monocular diplopia. Patients with cortical lens opacities often present complaining of poor vision but still have a Snellen acuity of 6/9. Testing with the use of neutral density filters reveals the true state of affairs.

Haloes may also be produced by diffraction around opacities within the optic media, in exactly the same way as with water droplets in the oedematous cornea.

Posterior sub-capsular lens opacities typically occur as a complication of systemic steroids. They may also occur naturally and can produce a dramatic deterioration of vision, often with distortion, but very little physical sign. This is because they are placed at the nodal point of the eye.

Occasionally the lens may become intumescent producing angle closure glaucoma.

Very occasionally the lens capsule may leak and this provokes an intense uveitis, with a high intra-ocular pressure.

MANAGEMENT

Lens-induced glaucoma, whether because of lens intumescence or phaco-anaphylaxis, is an emergency because of the massive rise of intra-ocular pressure and should be treated by reducing the intra-ocular pressure with Acetazolamide and urgent surgical intervention to remove the cataract.

The only other indication for cataract surgery is that the patient wishes to see better and is prepared to be submitted to surgery to gain that end.

Using an extra-capsular technique and a posterior chamber lens, I find very few contra-indications for surgery but there are quite a lot of special considerations. A brief digression to discuss the history of cataract surgery and intra-ocular lenses will illustrate the potential problems of eye surgery and I hope show why the present technique, whatever its limitations, has revolutionised ophthalmic practice.

CATARACT SURGERY

Until 1969 an extra-capsular technique of surgery was used, where the anterior capsule of the lens was breached, the nucleus expressed, and the lens matter irrigated. Without the use of an operating microscope the posterior capsule could not be adequately cleaned and secondary opacification was the rule requiring needling. Uveitis and glaucoma were frequent early complications and retinal detachment a frequent later complication.

The use of the cryoprobe, to extract the lens intact, marked a dramatic improvement in surgical technique with the instant production of a clear pupil. The inherent disadvantage of this technique is that the natural support to the anterior vitreous face is lost and the post-operative incidence of detached retina, macular oedema and glaucoma is high, and the management of aphakic glaucoma and aphakic detachment is not as straightforward as it is in the normal, unoperated eye. The incidence of aphakic detachment is about 10 percent, occurring mainly within the first year.

APHAKIC SPECTACLE CORRECTION

Many patients had little difficulty in coming to grips with cataract glasses but a significant proportion felt themselves to be visually crippled.

The problems occur because the lenses are thick and produce a magnification of about 30 percent. This means that a patient with a unilateral cataract would not benefit from surgery unless they were prepared to wear a contact lens. Because of the problems of spectacle correction the patient was required to wait until the cataract had 'ripened' to appreciate the resulting clarity despite the problems of magnification and distortion and contracted field. In addition, because of the thickness of the lens, centering has to be pinpoint accurate. (A displacement of 1 mm of a 10 dioptre lens produces 1 dioptre difference.) Unfortunately the glasses are heavy and tend to slip and repeated visits to the optician are required. Plastic lenticulars are lighter weight, but still heavy, and even more cosmetically unacceptable.

Thick and heavy
Ugly
Peripheral distortion – limiting field of vision
Prismatic effect of periphery of lens, producing a ring scotoma and "jack-in-the-box" phenomenon.
Magnification – by factor of one third, producing optical imbalance unless the other eye is also aphakic.
Problems of fitting – decentration of 10 Dioptre lens by 1 mm produces 1 Dioptre alteration in effective power of lens.
Expensive

Table 2 – Problems associated with aphakic spectacles

CONTACT LENSES

Contact lenses have a valuable place. By moving the lens to the surface of the eye the magnification is reduced and they can, therefore, be used for cases of unilateral cataract. Many people find the lens impossible to handle and it is unsuitable for many eyes, especially where allergy or dry eye is present.

Difficult to handle
Not always tolerated
Can produce corneal vascularisation – though this is usually reversible with limited wear.
Require regular attention and replacement.
Very expensive – especially when one takes into account the need for additional aphakic correction.

Table 3 – Problems associated with aphakic contact lens wear

The extended wear contact lens, which is worn all the time, requires frequent replacement but is an alternative where the patient cannot handle the contact lens.

The contact lens is not a completely safe alternative to an intraocular lens implant. Long-term contact lens wear is associated with corneal damage leading to vascularisation. The major advantage of contact lenses over intra-ocular lenses is that the former are easily removed.

INTRA-OCULAR LENS IMPLANTS

The use of I.O.L.s was pioneered in England. Harold Ridley pioneered posterior chamber lenses and Peter Choyce pioneered anterior chamber lenses.

There was a high incidence in the early days of serious complication including uveitis, glaucoma and hyphaema (the UGH Syndrome). Many of the problems were associated with the standards of manufacture and sterilisation and as these have improved the incidence of purely lens-associated complications is negligible.

1. **All lens styles**
Dislocation
Decentration
Deposits on lens
Wrongly labelled lens
Ocular toxicity
2. **Anterior chamber and iris clip lenses**
IOL is visible
Eye very tender to touch
Use contra-indicated – all types of glaucoma corneal endothelial dystrophy ocular inflammation significant diabetes mellitus
3. **Iris clip lenses only**
Use contra-indicated in all situations where pupillary dilatation may be required, eg: high myopes who are at great risk of developing retinal detachments, diabetics who may require laser treatment, pre-existing macular changes.
Requires intact iris sphincter
Inherently very unstable
Promotes macular dysfunction

Table 4 – Problems associated with intra-ocular lenses

The anterior chamber lens is still the only lens available for secondary implantation. The particular problem associated with anterior chamber lenses which makes it second best is the proximity to the corneal endothelium, which is a non-regenerating cellular mono-layer which maintains corneal transparency. There is a very high incidence of corneal decompensation leading to bullous keratopathy between three to ten years after operation.

The almost universal use of an intra-capsular technique in the 1970s promoted the development of lenses which relied on the iris for support. These produced a massive number of surgical problems including long term corneal damage and in the short term lens dislocation. They do not protect the eye from developing a retinal detachment and they have the added disadvantage that the pupil cannot be dilated for the retina to be seen. Because of their attachment to the iris they tend to produce chronic uveitis and are contra-indicated in patients with pre-existing glaucoma or uveitis.

Even where the preoperative appearances of the macula were normal, the incidence of macular oedema and

degeneration following iris clip lens implantation was very high (more than 15%).

MODERN DEVELOPMENTS

Use of the operating microscope has greatly reduced a lot of the surgical complications by simply providing a better view. As a result of this the extra-capsular technique has been revived and all the lens matter can be seen to be evacuated and any attached protein fibrils polished off the posterior capsule. The plastic lens can now replace the natural lens within its physiological position. This retains the natural rigidity of the lens-iris diaphragm, supporting the anterior vitreous face and reducing dramatically the incidence of retinal detachment and macular oedema post-operatively. In addition, it is isolated from the cornea and the incidence of corneal decompensation is again greatly reduced.

CONTRA-INDICATIONS TO CATARACT SURGERY WITH POSTERIOR CHAMBER IMPLANT

If the cataractous eye has no perception of light, removing the cataract will not restore visual function. Even a hypermature cataract, where the retina is intact, will allow perception of light. Some estimation of retinal function can be obtained by projection of light but this gives no information about macular function. However, if the cataract is so dense that the macula cannot be visualised and if retinal function is thought to be normal, then the patient can be promised an improvement in vision if an intra-ocular lens is used. This was not the case with aphakic glasses, since for the patient with macular dysfunction and resulting loss of central vision, aphakic glasses are singularly valueless.

Glaucoma, whether open angle or associated with a shallow anterior chamber, does not offer a contra-indication to surgery – though for the patient with advanced field loss opening the eye may produce a catastrophic alteration in the retinal circulation.

For diabetics the problem is a little bit more complex but I am now using implants in all of them. The insult of surgery can provoke a neovascular response and they need to be watched carefully in the early post-operative phase. The lens implant can produce irritating reflections for the operator, which make photo-coagulation awkward and the edge of the lens interferes with the view of the equatorial retina.

Patients with pre-existing corneal endothelial decompensation need to be warned of the possible risk of a rapid decompensation in response to surgery, which would necessitate corneal grafting. If this has already happened in one eye it is technically no more difficult to perform a simultaneous corneal graft and cataract surgery than to do the two operations separately.

All infection, however trivial, represents a contraindication to surgery since infective endophthalmitis, even with prompt and adequate antibiotic treatment, invariably results in no perception of light.

The patient needs to be as medically fit as possible. Certain cardiovascular problems make the choice of local anaesthesia desirable. A poorly controlled diabetic or a grossly anaemic patient is no more suitable for local anaesthesia as far as the surgeon is concerned than they are for general anaesthesia as far as the anaesthetist is concerned. The patient who is dyspnoeic at rest and cannot lie still without gasping is probably the only patient who is truly inoperable.

SURGICAL TECHNIQUE

The incision is via the upper limbus, where the upper lid affords a natural protection and if necessary allows the pupil to be enlarged or iridectomies performed, without producing polyopia. It is the only site of easy access for the surgeon. The lateral approach is used for a patient with a functioning trabeculectomy and a pupil that will dilate.

Pre-operatively the pupil requires to be fully dilated to minimise manipulation of the iris and optimise the view during surgery. Most cases of posterior capsule rupture occur because the view is poor.

The natural lens consists of small molecular weight crystalline protein encapsulated in basement membrane. It is acellular, apart from a few cells at the equator which continue to produce protein throughout life and these must be removed at the time of surgery to prevent secondary cataract formation.

Access to the lens is gained by a slit across the upper pole, through which the lens nucleus is expressed and the cortex irrigated and aspirated. The capsule is then polished and the plastic lens inserted and at all times the cornea is protected by the anterior lens capsule, which is only removed after the plastic lens is in place. The cornea is not deformed at any point during the operation and this adds to the protective effect of extra-capsular surgery on the cornea. The use of Visco elastic agents, such as Healonid (hyaluronic acid) further protects the cornea.

Though the extra capsular technique is more difficult to learn and perfect than the intra-capsular technique, the operator does not require skilled assistance, which is essential with intracapsular surgery.

The major surgical problem is vitreous loss following posterior capsular rupture. Careful vitrectomy techniques minimise the risk of aphakic detachment and very frequently it is still possible to use a posterior chamber lens and certainly always possible to use an anterior chamber lens. In the event of vitreous loss, macular function is still the most likely casualty.

Subluxation of the plastic lens may occur as a long term complication but is remarkably rare considering the supposed laxity of the zonules. Removal of the lens is rarely indicated, since its removal will inevitably produce vitreous loss, and massive intra-ocular haemorrhage.

COMPLICATIONS OF CATARACT SURGERY

The early complications which are common to all surgical procedures can be particularly devastating to the eye. Wound dehiscence requires immediate repair to reduce the risk of intolerable corneal astigmatism and to remove the tissue which holds the wound open and allows later ingress of bacteria.

Local anaesthetic is not a totally safe alternative to general anaesthetic. Retro-bulbar haemorrhage, perforation of the globe (especially likely with the long thin-walled myopic eye) and vasospasm of the optic nerve head producing optic nerve infarction are occasional complications. More frequently, the patient will fidget and surgical standards suffer slightly as a result.

The incidence of major ophthalmic complications, such as glaucoma and retinal detachment, are vastly reduced using the extra-capsular technique such that the major problems produced by cataract surgery are astigmatism and posterior capsular thickening.

1. Anaesthetic		
2. Early Surgical	(a) general:	infection
		wound dehiscence
		bleeding
		inflammation
	(b) specific:	vitreous loss
		lens dislocation
3. Late Surgical		
		glaucoma
		retinal detachment
		macular oedema
		vascular occlusion
		corneal decompensation
4. Capsular thickening		
5. Suture problems		
6. Astigmatism		
7. Anisometropia		
8. Unknown – possibly tissue erosion		

Table 5 – Complications of cataract surgery

ASTIGMATISM

Astigmatism complicates all surgery to the globe but is an especial problem to the cataract surgeon with the larger incision. A large cylinder plays havoc with biometry and with the patient's ability to see normally. Careful technique reduces the astigmatism.

LENS CAPSULE THICKENING

This is not infrequent and complicates 20 percent of cases within the first two to three years. It occurs more readily when there is not the capsule stretching effect of an intra-ocular lens present.

Before the advent of the YAG laser the only approach was needling, either trans-camerally by a corneal stab incision, or via the pars plana. The latter approach requires a great deal of bravery and the former is difficult with any posterior chamber lens and impossible with the 7 mm optic.

Now, using the YAG laser, the membrane can be popped as an outpatient procedure without mydriasis. The only disadvantage is that it requires accurate focus and is not possible in a patient who moves significantly. Bearing this in mind, there is a small group of patients in whom I would perform a primary capsulotomy at the time of surgery.

The advantages conferred on the eye by the extra-capsular technique with posterior chamber lens are so great that I feel the disadvantages of posterior capsular thickening are completely offset.

INTRA-OCULAR LENSES

These are made of clinical quality Perspex (Polymethylmethacrylate), with a UV absorber incorporated as routine. The PMMA is in cast sheet form, from which the I.O.L. blank with the appropriate surface power is cut with computer control. This is then profiled into the required shape. The finished lenses are tumble polished and cleaned. Ethylene oxide gas is used for sterilisation, followed by aeration for several days to remove the residue. The lens style currently used has a 7 mm diameter lenticular with C-shaped loops which flex to allow insertion and then spread to fill the available space. The 7 mm optic seems to remain better centred.

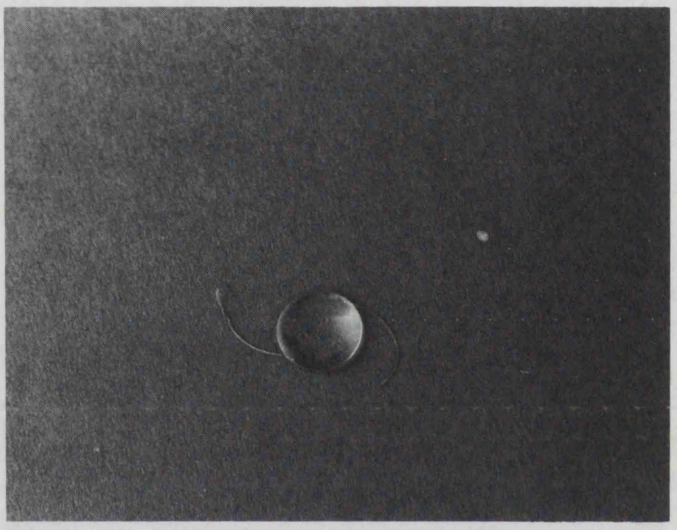

Fig 1 – An intra-ocular lens [IOL]

The current fashion is for a one piece lens, where the loops and optic are cut from a single pre-form rather than with the loops joined on.

Surface deposits on the lenticular can be a problem, especially in diabetics and especially where a clear view into the eye is required. With this in mind, surface modified lenses have been developed. Of the many chemicals tried Heparin alone has been found to be capable of combining in a stable solution with PMMA. My clinical impression is that the lenses do appear clearer at one week post-op but that this difference is not evident at about six months post-op compared with the one piece lens. Since it offers no clear advantage and costs three times more than the standard lens I tend to limit its use to the very young (ie. younger than an arbitrary 62).

BIFOCAL LENSES

Another recent development is the multi-focal lens, which aims to restore the apparent ability to accommodate. If emmetropia can be achieved these work well. If there is a significant operative cylinder or the biometry was inaccurate, the lens can still be used as a monofocal, though there are sometimes problems with refraction. Some patients do not gain the expected clarity of vision. Their major indication is for the young patient with a unilateral cataract.

$$P = A - 2.5\,(AL) - 0.9K$$

where P = IOL power
AL = axial length of eye (mm)
A = lens constant
K = keratometry reading (in dioptres)

Table 6 – SRK formula for lens power calculation. So called after Dr Sanders, Retzlaff and Kraff, the three USA surgeons who devised it.

BIOMETRY

The strength of lens used will depend for any given refraction on the style and shape of the lens and its position within the eye. Each style of lens has its own A-constant, which takes these factors into account.

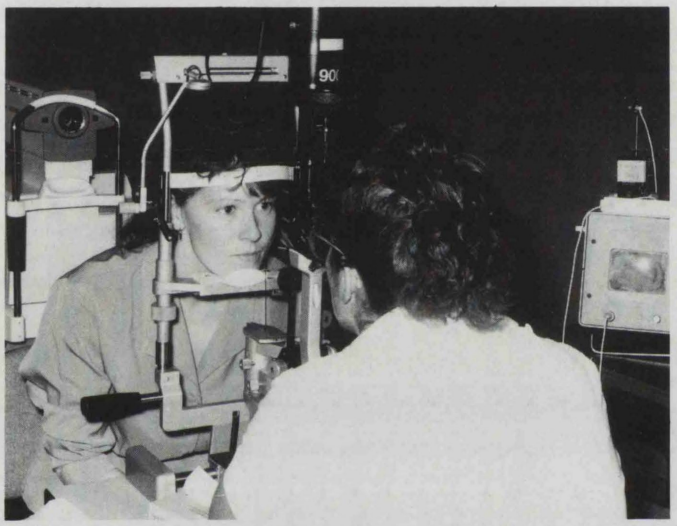

Fig 2 – Patient on the left, in position for biometry. The electronic keratometer [purchased from Sight Saver Appeal funds] is behind the patient. The ultrasound probe rests on top of the axial length computer on the right.

A standard implant will give satisfactory results in 85 percent of cases without biometry. The remaining 15 percent of cases will have unsatisfactory results and in 5 percent the pseudophakic correction is grossly in error.

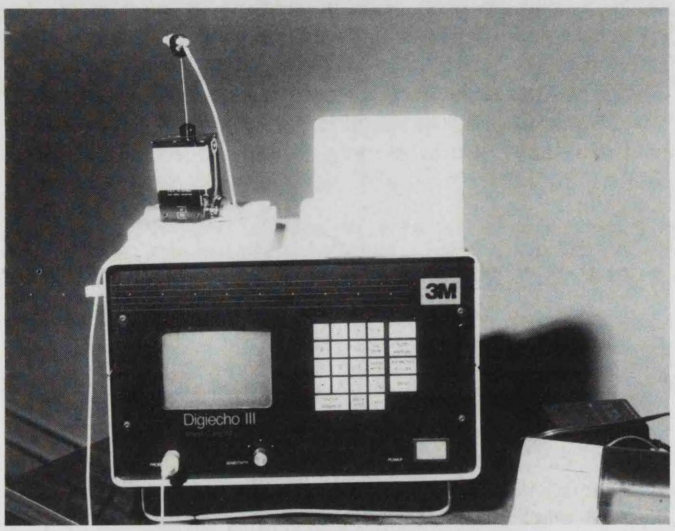

Fig 3 – The ultrasound probe and the axial length computer.

Ultrasound is used to measure the length of the eye. The SRK formula is the most commonly used nowadays to determine the lens power required. The results for the average length of eye are remarkably accurate. For the very short and the very long eye the results are less accurate.

CHOICE OF LENS POWER

For the patient with a unilateral cataract the aim must be to match the refraction of the two eyes post-operatively.

The ideal, especially for the elderly population which is largely housebound, is about 2 dioptres of myopia. This gives a reasonable acuity for near and distance without the need for any spectacle correction.

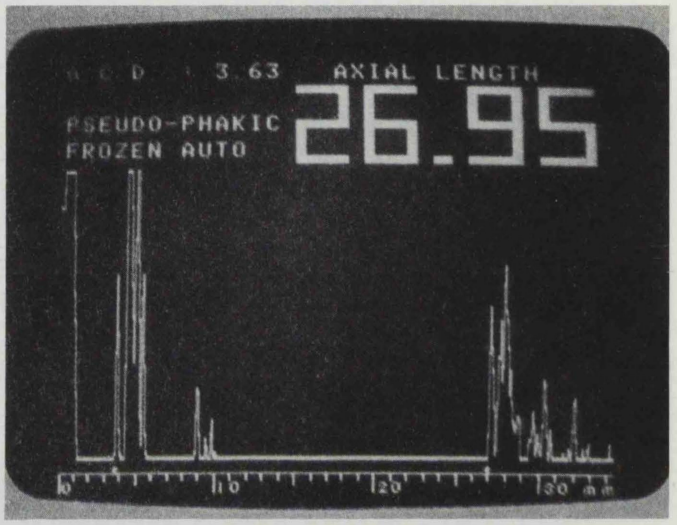

Fig 4 – A specimen printout from the computer.

Most patients seem to be happiest doing what they have been used to doing before cataracts develop. The person who routinely uses reading glasses wishes to continue using reading glasses. The only group of patients who are delighted to alter their spectacle practice are the very high myopes.

DAY CASE SURGERY

Day case surgery is only really considered suitable for patients who have cataract surgery under local anaesthesia.

Since possibly two visits pre-operatively are required, along with the journey to and from the unit on the day of surgery and the day following surgery, it is a procedure which is only suited to patients who live nearby and who have ready access to transport. It is also only suited to the patient who has relatives or good friends who can help them through the first day.

Lancaster patients are already in and out of hospital within 24 hours.

POST-OPERATIVE PRECAUTIONS

There are very few constraints on the patient's postoperative activity. Light, physical work may be

undertaken within two weeks of surgery, though heavy manual work should be left for about three months.

The wound is more or less watertight within 24 hours and the tensile strength of the wound is almost fully recovered by six weeks, though it takes about three months for full healing. From this it follows that the patient should not rub the eye post-operatively.

	Correction	*Cost for one eye*	*Total cost*
	IOL	**£48**	**£48**
Pseudophakic	near distance	£18 £18	£36
Aphakic	near distance	£47 £47	£94
Unilateral Aphakia with daily wear contact lens	Contact lens + glasses	£50-200* (ave 100) £36	£136**
Unilateral Aphakia with extended wear contact lens	Contact lens + glasses	£100-400* (ave 200) £36	£236**
Bilateral Aphakia requiring aphakic correction	Contact Lens over correction (reading) aphakic (near) (distance)	(£50-200)x2 (ave 100) £18 £47 £47	£312**

* prices vary at discretion of Optician
** check ups required, range £10-25 per visit, every three months

Table 7 — Costs to Hospital Eye Service of post-operative correction. (All these are recurring charges, at least annually, with the exception of the intra-ocular lens)

A combination of steroid and antiobiotic drops are used routinely.

If the surgical procedure was uncomplicated the patient can safely be discharged from the clinic at six weeks post-op and glasses can then be arranged, when the wound healing is almost complete.

Posterior capsular thickening produces gradually deteriorating vision. The suture can cause problems. Nylon is routinely used. It is inert and need not, therefore, be removed as a routine but it does tend to disintegrate and break and in that case will produce a foreign body sensation and need to be removed.

Patients are routinely warned of these two problems and asked to return should they occur so that the problem can be remedied.

BILATERAL SURGERY

My personal series of cataract surgery at Lancaster has produced a complication rate of endophthalmitis in less than 0.1 percent of cases. With this record, I am happy to offer a simultaneous bilateral procedure in selected patients, usually those who are very old with poor vision in both eyes especially where the prognosis is guarded in the light of co-existing macular degeneration. Most patients prefer the single admission and benefit from regaining good binocular vision.

MINIMAL ACCESS SURGERY AND THE FUTURE

Since refractive problems caused by astigmatism are the remaining major complication of cataract surgery, a reduction in the size of the incision must offer distinct advantages.

Phaco-emulsification, where the lens nucleus is fragmented using ultra-sound, was flirted with some ten years ago but fell from fashion because of the problems in maintaining a constant irrigation-aspiration pressure. Microchip technology now allows a constant intra-ocular pressure to be maintained and ultrasonic phacoemulsification is beginning to be the realistic way forward. Lens technology still needs to catch up. Foldable lenses are at present being used but, unfortunately, they tend to retain their memory and flex within the eye. Oblong lenses, which have a 5 mm insertion diameter but when rotated within the eye have a 7 mm optic in the horizontal axis, are at present the best compromise.

The science fiction future will be for an injectable lens. This would need to stay in the lens capsule in its fluid state, be capable of remaining fluid for a sufficient time for it to be injected and then able to set in saline at 37°C. In addition it would, of course, have to be non-biodegradable and stable chemically. In order to retain the advantages that biometry affords there would also have to be some technique for measurement of injected lens power while on the table or some technique for intra-ocular lens fashioning post-operatively. Ideally this material would retain a rubbery texture, which would allow true accommodation.

The development of the Excimer laser is set to revolutionize ophthalmology and this may well have a place to play in the management of post-operative astigmatism.

CONCLUSION

With today's generation of intra-ocular lenses and microsurgical techniques, safe and effective cataract surgery can be performed with minimum post-operative restriction to the patient. Careful selection and high standards of surgery are, however, vital to maintain high quality results, since serious complications can occur which lead to blindness.

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