# Cataract assessment

## Anatomy

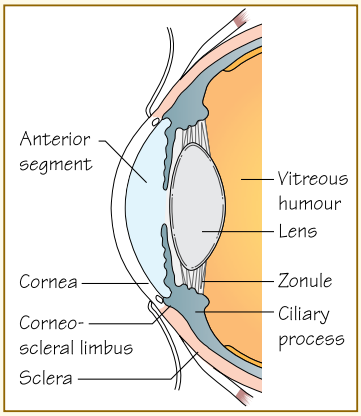
The **lens** is crystalline with an inner nucleus of older inactive cells and an outer cortex, the whole being encapsulated. The **epithelium** is active metabolically, it synthesizes protein for **lens fibres**, transports amino acids and maintains a cation pump to keep the lens clear. At the equator of the lens, epithelial cells differentiate into lens fibres, which lose their organelles and ability for aerobic metabolism

**Zonule filaments** suspend the lens **ciliary processes** to the **ciliary muscle**. When the muscle contracts the filaments relax allowing the lens to become more convex with a shorter focal length for reading

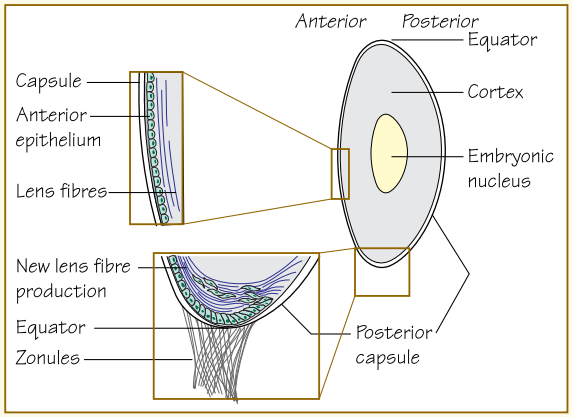
## Definition

**Cataract**: Opacity of the lens of the eye, which occurs when fluid gathers between the lens fibres. The refractive index alters and causes light scatter with resultant blurred vision. Acquired lens changes occur in 95% of people over 65, however, not all these people will require cataract surgery

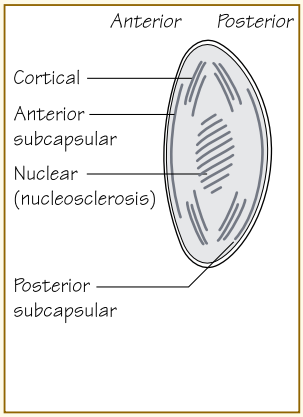
### Diagram of normal anterior segment




### Close up of normal lens cross-section




### Lens with cataract



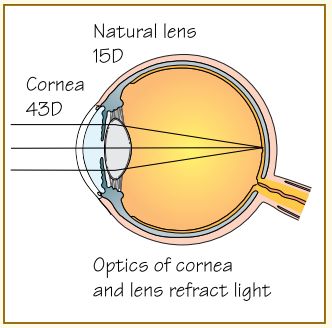

### Causes of cataract

- Old age (commonest)
- Associated with other ocular and systemic diseases (diabetes, uveitis, previous ocular surgery)
- Associated with systemic medication (steroids, phenothiazines)
- Trauma and intraocular foreign bodies
- Ionizing radiation (X-ray, UV)
- Congenital (dominant, sporadic or part of a syndrome, abnormal galactose metabolism, hypoglycaemia)
- Associated with inherited abnormality (myotonic dystrophy, Marfan's syndrome, Lowe's syndrome, rubella, high myopia)

Slit lamp view of nucleosclerosis

### Biometry: intraocular lens power calculation

The desired implant should produce a sharp image on the retina. Since each eye has a different corneal curvature and axial length, the implant size has to be measured preoperatively in each patient. The optics of the eye are such that light is refracted by the cornea (effective power of 43D) and by the natural lens (effective power 15D), both of these together give the total power of the focusing components of the eye. A special equation is used to calculate the intraocular lens power, which is usually in the range of 19–22D, with some very short-sighted eyes needing lower powers and long-sighted eyes needing higher powers for clear focused distance vision




## Aims

**1** Anatomy of the lens.
**2** Causes of cataract.
**3** Symptoms and signs.
**4** Treatment of cataract.

Cataract is the most common cause of blindness in adults worldwide.

## Symptoms

- Reduced visual acuity (near and distant objects).
- Glare in sunshine or with street or car lights.
- Distortion of lines.
- Monocular diplopia.
- Altered colours (white objects appear yellowish).
- Not associated with pain, discharge or redness of the eye.

## Signs

- Reduced acuity measured on a Snellen chart or LogMar and near vision chart.
- An abnormally dim red reflex is seen when the retina is viewed with an ophthalmoscope at arms length. Nuclear cataract causes a central black shadow across the red reflex and cortical cataracts cause black spoke-like shadows coming from the edge of the red reflex.
- Reduced contrast sensitivity can be measured by the ophthalmologist.
- Only very dense cataracts causing severely impaired vision cause a white pupil.
- After pupils have been dilated, slit lamp examination shows whether the cataract is cortical, nuclear or posterior subcapsular and allows fundus examination.
- Cataract in children is unusual but may be associated with a white pupil, inability to fix on a target (e.g. a light) and the development of a squint.

**TIP**

Pupils are normal if there is no other ocular or optic nerve disease.

## Treatment

- Cataract alters the refractive power of the natural lens so a change in glasses prescription may allow good vision to be maintained. The eye may become more myopic (lenticular-induced myopia) or hyperopic. The legal requirement for driving a car in the UK is 6/10 in one eye. NB, the Snellen chart only has lines corresponding to 6/9 and 6/12.
- If further changes occur in the lens, with increased disturbance of the lens fibres, the visual acuity cannot be improved with glasses and surgical removal of the cataractous lens is required.
- Modern surgery involves removal of the lens fibres, which form the nucleus and cortex of the cataract, leaving the posterior epithelial capsule to hold the new artificial lens and keep the vitreous humour away from the anterior chamber.

## Preparation for cataract surgery

- Biometry: ultrasound measurement of the length of the eye and keratometry to measure the curvature of the cornea and hence calculate the power of the implant to be inserted in the eye during surgery.
- Confirm that general health problems are stable, particularly hypertension, respiratory disease and diabetes.
- Some medication increases the incidence of haemorrhage. Warfarin does not need to be stopped but the INR should be less than 3. Aspirin may be stopped 1 week before surgery.
- Inform patients of expected outcome and the complications of surgery (informed consent).

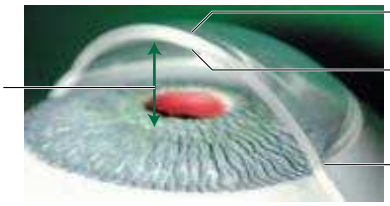
**KEY POINTS**

- Cataract is common, it is one of the three main causes of blindness worldwide.
- Can occur at any age and in all races.
- Effectively treated by glasses in the early stages and by surgery when more advanced.

# Cataract surgery

An operating microscope is needed. In order to reach the lens, a small corneal incision is made close to the limbus for the phaco-probe. It is important to appreciate ANTERIOR CHAMBER DEPTH and to keep all instruments away from the corneal endothelium, in the plane of the iris

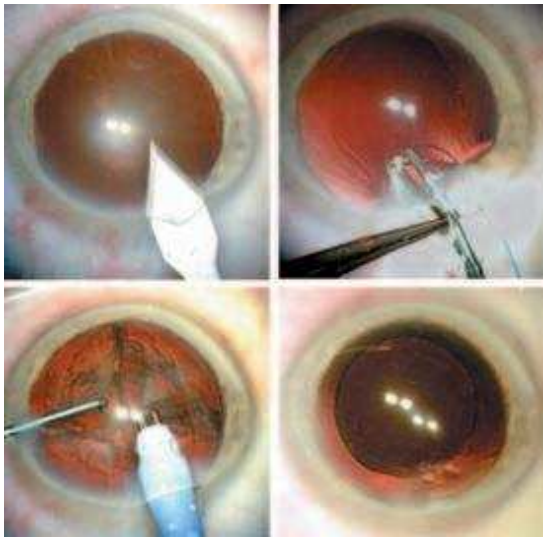
Model of eye showing anterior chamber depth




## Phacoemulsification surgery

1. Keratome corneal incision

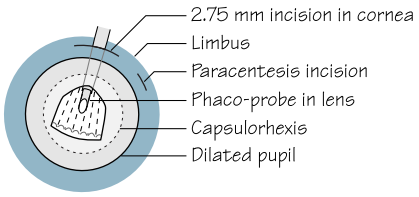
3. Foldable intraocular lens (IOL) being inserted



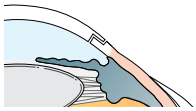
2. Phaco-probe sculpting lens nucleus

4. IOL unfolded in capsular bag

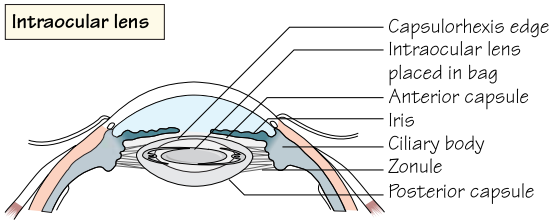
## Phaco-probe

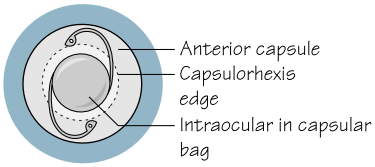



Corneal incision profile – self-sealing sutureless wound



## Intraocular lens




**Steps:**

- Corneal incision 2.75–3.2 mm
- Viscoelastic to anterior chamber
- Capsulorhexis
- Hydrodissection
- Phaco removal of nucleus
- Aspiration of cortex
- More viscoelastic:
- *A folded IOL is inserted under a cushion of viscoelastic fluid, which protects the corneal endothelium; the lens unfolds spontaneously within the capsular bag*
- Viscoelastic removed and replaced with balanced salt solution
- Self-sealing wound
- Subconjunctival injection of steroid and antibiotic
- Eyepad and protective eye shield

**New techniques**
**Clear lens surgery – a novel lens refractive technique**

Phacoemulsification is used for cataract surgery and also for CLEAR LENS surgery. Clear lens surgery is called lens refractive surgery and is increasingly being offered for presbyopia and high myopia. Technology for lens surgery is accelerating at a phenomenal speed

1. Clear lens IOL – the patient's lens is removed and an IOL of a different power inserted. E.g. Prelex lens exchange – this is a special IOL which tilts with accommodation maintaining clear 'unaided' distance and near vision! Myopic patients having LASER corneal refractive surgery now may opt for this when prebyopic!

2. Phakic IOL – the patient's clear lens is left *in situ* and a second lens placed in front of it – used for myopia correction

Both these techniques have potential complications and the patient needs to be fully informed before going ahead

## Aims

1 Understand methods of anaesthesia and cataract removal.
2 Be able to explain cataract surgery to a patient.

Microsurgical cataract surgery in developed countries has reached a very high level due to the developments in microsurgical instruments and intraocular lens design. There is controlled and precise removal of part of the lens with the assistance of an operating microscope. Part of the lens capsule is retained to hold the implant within it.

## Definitions

**Pseudophakia**: An eye that has had a cataract removed and artificial intraocular lens implanted.
**Aphakia**: An eye that has had a cataract removed without an artificial lens inserted.

## Anaesthesia for cataract surgery

**TIP**
Most adult cataract surgery is done under topical or local anaesthesia. The patient may see bright lights and different colours, shadows of the surgeon's hands moving or complete darkness during surgery.

### Local anaesthesia

- Topical (drops of proxymethocaine or amethocaine).
- Subtenons using a blunt canula to administer 2 ml of lidocaine.
- Peribulbar injection to distribute 5–10 ml lidocaine within the orbit.
- Retrobulbar injection to direct 1–2 ml lidocaine within the muscle cone—now becoming less commonly used.

### Sedation

Intravenous drugs may be given with local anaesthetics but are not preferred as the patient could drift off to sleep and then suddenly wake up with a jolt and move their head—undesirable in cataract surgery.

### General anaesthesia

This is used for young and uncooperative patients.

## Surgical technique for cataract removal

Patients have to lie supine so a microscope with a bright light and good magnification can be positioned above them. The surgeon works from the side or above the head, looking down the microscope, using the red reflex from the retina to aid cataract removal.

### Draping

Before surgery can start, the eyelids and lashes are covered with a thin transparent plastic drape in order to keep contaminated lashes out of the surgical field. Staphylococci live in abundance on the lashes. The drape is light and also covers the face—lifted up from it as a small tent—to protect the face from irrigation fluids used in the surgery, which are collected into a small bag at the side of the head.

### Small speculum

The eyelids are kept open by a combination of the drape and a small wire speculum which does not cause the patient discomfort.

**TIP**
Phacoemulsification lens surgery with small, foldable intraocular lens implants is the gold standard. It gives rapid visual rehabilitation with a low complication rate.

### Surgery

Extracapsular cataract surgery is a technique in which the posterior capsule of the lens is retained, keeping the vitreous separate from the anterior chamber of the eye. It may be small or large incision surgery.

- **Small incision surgery** is by using phacoemulsification (phaco) to crumble the lens in the eye. Fragments are irrigated out automatically. A soft, foldable intraocular lens implant (IOL) can be inserted through the small incision into the lens capsule (posterior chamber IOL). This incision is usually sutureless, or a single suture is placed, which can be removed as early as 2 weeks after surgery. Phaco is the most commonly used technique.
- **Large incision surgery** involves removal of the entire nucleus as one piece; the soft cortex is aspirated and a rigid or soft implant is inserted. The corneal wound requires microsutures, which are removed as late as 8 weeks after surgery.

### Implant power

The IOL power is carefully calculated to take into account the patients postoperative visual requirements. For instance, a myopic person may prefer to remain slightly myopic after surgery so that they can still read without glasses. Multifocal IOLs and accommodative IOLs are increasingly being used.

### Clear lens surgery for presbyopia

Over the next few years an increasing number of people in their fifties will have their lenses removed for presbyopia, in order to avoid having to wear reading glasses, and special accommodative IOLs will be inserted. Hence the number of people developing cataract will be reduced.

**KEY POINTS**
- Microsurgery involving the replacment of the natural lens with an artificial one.
- Day-case procedure under local anaesthesia.
- Patient needs to be able to lie still and flat for 30 min.

# Cataract surgery postoperative care

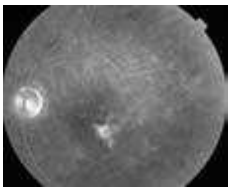
| Early postoperative problems | Symptom | Sign | Treatment |
|---|---|---|---|
| Raised intraocular pressure | Pain, deep ache, blurred vision | Hazy cornea | Ophthalmologist needs to measure pressure and treat with systemic acetazolamide 250 mg 2–4 times daily (1–2 days) and glaucoma drops |
| Leaking incision | Poor vision | Siedel positive with fluorescein | Ophthalmologist may need to suture the wound in the operating theatre. If the anterior chamber is deep and the ocular pressure is normal, a soft contact lens may be placed on the eye. Daily review is required |
| Subconjunctival haemorrhage | Red eye. No pain | Diffuse redness on the globe | Continue drops. Reinforce good technique for instilling drops |
| Corneal oedema | Poor vision | Hazy cornea | Ophthalmologist needs to exclude raised pressure and increase topical steroid drops |
| Epithelial erosion (conjunctiva or cornea) | Gritty, watering | Fluorescein staining, may have injected bulbar conjunctiva | Continue drops, reassure. Monitor carefully to exclude early infection |
| Conjunctivitis | Pain, redness with mucopurulent discharge | Swollen, red tarsal conjunctiva while maintaining good vision | Prescribe different antibiotic, (e.g. ofloxacin) to be used 2 hourly. Frequent review to confirm no progression to endophthalmitis |

Leaking wound – a positive Siedel test (trabeculectomy bleb leak)

Hypopyon indicates endophthalmitis

Fibrin plaque – intense postoperative inflammation in endophthalitis

| Sight-threatening postop problems requiring urgent treatment by ophthalmologist | Symptom | Signs observed with pen torch | Slit lamp signs observed by ophthalmologist | Treatment (by ophthalmologist) |
|---|---|---|---|---|
| Endophthalmitis | Painful, red eye usually with a mucopurulent discharge and poor vision at day 3–5 | Red eye with hazy cornea. A relative afferent pupillary defect indicates serious visual damage | Flare, cells and and hypopyon in anterior chamber | URGENT in-patient management. Intensive topical broad spectrum antibiotics (drops). Requires aqueous and vitreous sample for microscopy, culture and sensitivity |
| Macular oedema (retina) | Poor vision during first 60 days after surgery | Normal anterior segment of the eye | Slit lamp fundus examination and fluorescein angio-graphy show increased fluid in the retina around the fovea | Treated with anti-inflammatory drops (steroid and non-steroidal), steroid injection around the eye, systemic non-steroidal anti-inflammatory, e.g. neurofen |
| Opacity of posterior part of the original epithelial capsule of the natural lens (can occur between 1 month and 2 years after surgery) | Gradual deterioration of vision, as though cataract is reforming | White eye with no external abnormality. Red reflex from fundus may be obscured | Posterior capsule hazy or white. Implant is unaffected | Make a hole in the capsule using a YAG laser (clinic procedure requiring anaesthetic drops). Cornea, anterior chamber and implant are not affected by the laser |



Cystoid macular oedema (CMO) – typical colour fundus and fluorescein angiographic appearance

YAG capsulotomy hole made in thickened posterior capsule

Definitions:
Endophthalmitis = infection and inflammation involving the whole of the contents of the eyeball
IOP = Intraocular pressure
YAG laser capsulotomy = laser treatment for posterior capsular opacity
Siedel test = fluorescein test to look for wound leakage of aqueous humour from the eye

## Aims

**1** Awareness of normal and undesirable early and late postoperative events.
**2** Recognize postop complications from history.
**3** Use of pen torch and fluorescein drops to detect a leaking wound and see hypopyon.

## Routine postoperative management

Patients use steroid and antibiotic drops four times daily for 2–4 weeks after surgery. During that time they can read, take gentle exercise, shop, shower or bath and wash their hair carefully. The implant inserted at surgery normally gives them clear vision for distance (e.g. TV, buses) but they will need to wear reading glasses (approximate prescription +2.5D); these can be prescribed from 2–4 weeks after phacocataract surgery. Some patients have a multifocal implant inserted so they are less dependent on glasses for reading.

**Reading glasses**

Patients who have had phacocataract surgery usually have good vision from the first postoperative day and can be tested for spectacles (refraction) for reading 2 weeks after surgery.

In contrast, patients who have had large excision extracapsular cataract surgery have corneal sutures, which are not removed for 2–3 months. Only after these have been removed are reading spectacles prescribed, i.e. there is a longer rehabilitation period.

## Undesirable postoperative events (complications)

Watering and a foreign body sensation are common after surgery. Usually the patient can be reassured, but the possibility of infection—**endophthalmitis**—the most important sight-threatening complication, must be considered. This is an acute sight-threatening postoperative event that requires *urgent* admission and treatment. Its onset is usually 4–5 days after surgery. Symptoms include worsening vision and pain.

See Tables for early and late complications.

**KEY POINTS**

- Over 97% of cataract surgery is successful.
- Endophthalmitis is the most serious postoperative complication.
- Sympathetic ophthalmia affects the other eye—*rare* <0.01%.