

Lens

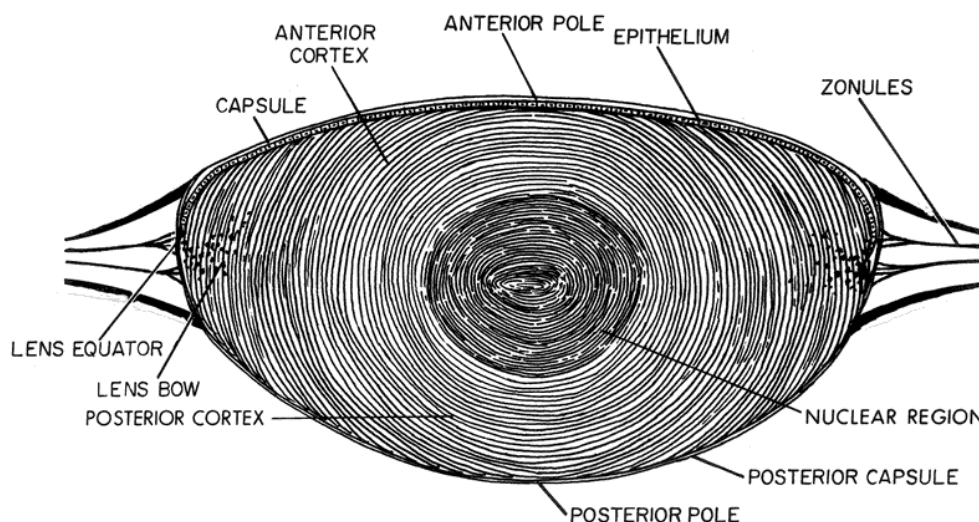
(Diseases of the lens)

Three diseases related to the lens will be discussed; all in this lecture:

- 1- Cataract (Acquired and congenital)
- 2- Aphakia
- 3- Ectopia lentis (Lens displacement)

Anatomy of the lens:

The crystalline lens is a biconvex, avascular transparent structure enclosed by a capsule. **The lens consists of:** **1- Nucleus:** the central compacted core, which represents the older lens fibers formed during intrauterine life and early years of life. **2- Cortex:** represents the newly formed epithelial cells, which elongate to form new lens fibers surrounding the old fibers (nucleus). These new lens fibers are continuously laid down subcapsularly throughout life, resulting in that the older layers acquire progressively deeper localizations within the lens. **3- The capsule:** which is the *thickest basement membrane* in the body and responsible for moulding the lens substance during accommodation.



Cross section through the lens

- A ring of zonular fibers, which insert in the equatorial region, suspends the lens from the ciliary body. As the zonule keeps the lens attached to the ciliary body, it can mould and change the shape of the lens during accommodation. Contraction of the ciliary muscles causing decrease in the tension of zonule on the lens capsule which is change the lens shape to more sphere by its elasticity and increasing the power of lens. "*Accommodation*"
- The lens grows in both anteroposterior and equatorial dimensions throughout life

Function of the lens:

1. The lens is one of the essential refractive media of the eye and focuses incident rays of light on the retina.
2. It adds a variable element to the eye's total refractive power (10–20 diopters, depending on individual accommodation) to the fixed refractive power of the cornea (approximately 43 diopters).

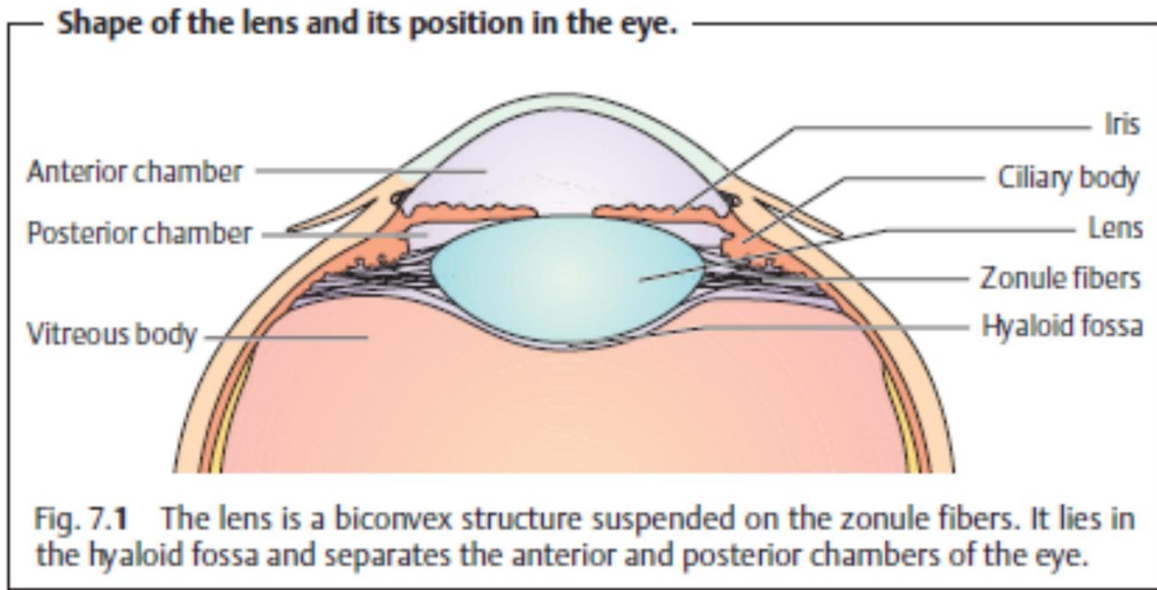
Shape: The fully developed lens is a **biconvex, transparent structure**. The curvature of the posterior surface, which has a radius of 6mm, is greater than that of the anterior surface, which has a radius of 10mm.

Weight: The lens is approximately 4mm thick, and its weight increases with age to five times its weight at birth. An adult lens weighs about 220 mg.

Position and suspension: The lens lies in the posterior chamber of the eye between the posterior surface of the iris and the vitreous body in a **depression of the vitreous body** known as the hyaloid fossa.

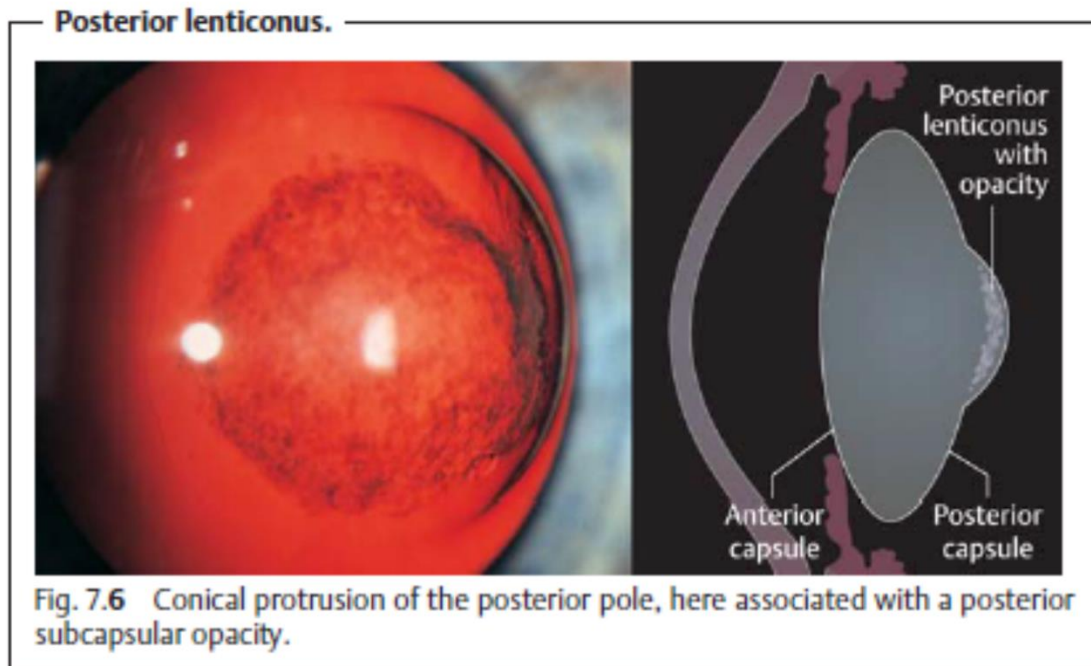
Together with the iris it forms an optical diaphragm that separates the anterior and posterior chambers of the eye.

Radially arranged **zonule fibers** that insert into the lens around its equator connect the lens to the ciliary body. These fibers hold the lens in position (Fig. 7.1) and transfer the tensile force of the ciliary muscle (Accommodation).



Developmental Anomalies of the Lens

1. **Lenticonus** is a circumscribed conical protrusion of the anterior pole (anterior lenticonus) or posterior pole (posterior lenticonus). A hemispherical protrusion is referred to as **lentiglobus**.
 - Symptoms include myopia and reduced visual acuity.
2. **Microphakia** refers to a lens of abnormally small diameter. Any interruption of the development of the eye generally leads to microphakia.



Symptoms and signs of diseases of lens:

- 1- **Cataract:** lead to painless impairment visual acuity.
- 2- **Presbyopia:** decrease in accommodation (due to decreased elasticity) leading impairment of near vision.
- 3- **Nuclear sclerosis:** lead to increase the difference between the refractive indices of the nucleus and cortex causes "index (lenticular) myopia".
- 4- **Monocular diplopia:** due to opacification or tilting of lens

Cataract

The normal lens is transparent, any congenital or acquired opacity in the lens or its capsule, irrespective to the effect on vision, is a **cataract**.

Cataract symptoms.



Fig. 7.7 a Visual image without a cataract.



b Visual image with a cataract: gray areas and partial loss of image perception.

Types of Cataract:

Cataract can be classified in the following way:

- 1- According to its site within the lens:
- 2- According to maturation: a- Immature:
- 3- According to its onset

1- According to its site within the lens:

- A** - Posterior subcapsular: just anterior to the posterior capsule.
- B** - Anterior subcapsular: just posterior to the anterior capsule.
- C** - Cortical: cataract involving the cortex.
- D** - Nuclear: cataract involving the nucleus. * Cataract can be detected by slit-lamp, direct ophthalmoscope (where we have black dots in the red reflex or total loss of red reflex) and B-scan

2- According to maturation:

- A - Immature:** if there is involvement of part of lens (any part), and other parts are transparent.
- B - Mature:** complete opacification of the entire lens.
- C - Hypermature Cataract:** which is a mature cataract liquefaction, leakage of fluids from the lens towards aqueous humor, shrinkage of lens and folding of capsule.
- D - Intumescent Cataract (phacomorphic cataract):** In case of immature or mature cataract, if there is influx of fluids from aqueous humor towards lens lead to swelling of the lens. Some time, this swelling will progress to a level sufficient to occlude the angle of AC results in "*Intumescent Glaucoma*".

3- According to its onset: either acquired or congenital.

Acquired Cataract

Causes are classified into the following:

- 1- Age-related cataract
- 2- Pre-senile cataract
- 3- Traumatic cataract
- 4- Drug-induced cataract
- 5- Secondary cataract

Age-related cataract: due to biochemical changes that occur with advancing age in the proteinaceous matter of the lens converting soluble into insoluble protein causing opacification, usually develops after the age of 60.

Pre-senile cataract: develops before the age of 60 in the following conditions:

- a- **Diabetes Mellitus:** High level of glucose in the aqueous humor so it diffuses into the lens, where glucose is metabolized into sorbitol by aldose reductase, then accumulation of sorbitol causes secondary osmotic overhydration leading to refractive changes (Myopia), then cataract.
- b- **Myotonic dystrophy:** 90% of patients develop cataract in the third decade.
- c- **Atopic dermatitis:** 10% of patients with severe atopic dermatitis develop cataract in the 2nd-4th decades of life.
- d- **Neurofibromatosis type 2.**

Traumatic cataract: trauma is the *most common cause of unilateral cataract* in young individuals:

- a- Direct penetrating injury to the lens.
- b- Concussion.
- c- Electrical shock is a rare cause.
- d- Ionizing radiation.
- e- Infrared radiation; as in glassblowers.

Drug-induced cataract:

- a- **Steroids:** both systemic and topical steroids are cataractogenic.
- b- **Chlorpromazine:** both corneal and lenticular deposits are dose related and usually irreversible.
- c- **Amiodarone** (anti-arrhythmic): lens deposits occur in 50% of patients.
- d- **Gold:** lens deposits occur in 50% of patients on treatment for longer than 3 years.
- e- **Allopurinol:** used in hyperuricaemia and chronic gout.

Secondary cataract: is a complicated (secondary) cataract develops as a result of some other primary ocular disease:

- a- Chronic anterior uveitis: it is the most common cause of secondary cataract.
- b- Acute congestive angle-closure glaucoma.
- c- High (pathological) myopia.
- d- Hereditary fundus dystrophies, such as retinitis pigmentosa.

Symptoms of cataract

An opacity in the lens of the eye:

- Causes a painless loss of vision;
- Causes glare;
- May change refractive error.

In infants, cataract may cause *amblyopia* (a failure of normal visual development) because the retina is deprived of a formed image. Infants with suspected cataract or a family history of congenital cataracts should be seen as a matter of urgency by an ophthalmologist.

Signs of cataract

- **Visual acuity is reduced.** In some patients the acuity measured in a dark room may seem satisfactory, whereas if the same test is carried out in bright light or sunlight the acuity will be seen to fall, as a result of glare and loss of contrast.
- **The cataract appears black against the red reflex when the eye is examined with a direct ophthalmoscope.** Slit lamp examination allows the cataract to be examined in detail and the exact site of the opacity can be identified.

INVESTIGATION

This is seldom required unless a suspected systemic disease requires exclusion or the cataract appears to have occurred at an early age.

Treatment of cataract:

- Treatment of cataract is **SURGERY**
- There is **NO** effective medical treatment

Indications of surgery:

1- Visual improvement: is the most common indication, whether it is mature or immature. If the patient feels that his vision is not enough to perform daily requirements surgery is indicated.

2- Medical indications: e.g., Intumescent Cataract (phacomorphic cataract) which might lead to intumescent glaucoma. Other example is dense cataract impaired visualization of retina in diabetic patients. (They need regular follow up to exclude retinopathy and even laser treatment for their retinae).

3- Cosmetic indication: is rare, as mature cataract causing white pupil (Leukocorea). Anesthesia used is general, local, topical and intracameral (injection of local anesthesia inside the AC). Choices one of them is according to method of surgery, general health of the patient and surgeon preference.

Cataract surgery للأطلاع

The operation involves removal of most of the lens and its replacement optically by a plastic implant under local rather than general anaesthesia.

The operation can be performed:

- Through an extended incision at the periphery of the cornea or anterior sclera followed by *extra-capsular cataract extraction (ECCE)*. The incision must be sutured.
- By liquification of the lens using an ultrasound probe introduced through a smaller incision in the cornea or anterior sclera (*phacoemulsification*). Usually no suture is required. This is now the preferred method in the Western world.

The power of the *intraocular lens implant* to be used in the operation is calculated beforehand by measuring the length of the eye ultrasonically and the curvature of the cornea (and thus optical power) optically (this is called Biometry)

Visual rehabilitation and the prescription of new glasses is much quicker with phacoemulsification. Since the patient cannot accommodate he or she will need glasses for close work even if they are not needed for distance. Multifocal intraocular lenses are now in use. Accommodating intraocular lenses are being developed.

Complications of cataract surgery

1. Vitreous loss.
2. Iris prolapse.
3. Endophthalmitis. A serious but rare infective complication of cataract extraction (less than 0.3%). Patients present with:
 - A painful red eye;
 - Reduced visual acuity, usually within a few days of surgery;
 - A collection of white cells in the anterior chamber (hypopyon).
 The patient requires urgent ophthalmic assessment, sampling of aqueous and vitreous for microbiological analysis and treatment with intravitreal, topical and systemic antibiotics.
4. Postoperative astigmatism.
5. Cystoid macular oedema.
6. Retinal detachment.

7. Opacification of the posterior capsule.
8. If the fine nylon sutures are not removed after surgery they may break in the following months or years causing irritation or infection. Symptoms are cured by removal.

Aphakia

- Congenital or acquired absence of the lens from the eye, or its absence from the pupillary area (luxated).
- An aphakic eye is usually strongly hypermetropic where parallel rays of light are brought to a focus behind the retina. All accommodation is abolished

Treatment:

- 1- **High powered convex lenses in spectacles:** High power spectacles lens causing magnification of the images on the retina (about 30% magnification), which will produce anisocoria (different sizes of image on the retina coming from the 2 eyes). Normal eye sending normal size image while aphakic eye with high power spectacle producing large image (30%). The cerebral cortex cannot fuse those 2 images with such high difference in their sizes. Other disadvantages of high power spectacles are including, limitation of visual field and heavy weight. * Cerebral cortex cannot fuse images difference in more than 5%. Therefore any difference which is more than 5% causing diplopia.
- 2- **Contact lens** (1% magnification). This is can be used without diplopia in aphakic eye if the other eye is phakic or pseudophakic.
- 3- **IOL (intraocular lens):** is the best way of correction as there is no magnification at all.

Congenital Cataract

Occurs in about 3:10.000 live birth, 2/3rd of cases are bilateral.

Causes:

1- Isolated hereditary cataracts: Account for about 25% of cases, mode of inheritance is most frequently **AD** (Autosomal dominant), yet **AR** (Autosomal Recessive) and X-linked inheritance can occur.

2- Metabolic cataract:

a- galactosaemia (Galactose -1-phosphate uridyl transferase "GPUT").

b- Lowe's (oculocerebral) syndrome: rare inborn error of amino acid metabolism which predominantly affects boys (X-linked).

3. Prenatal infections:

a- Congenital Rubella: cataract presents in 15% of cases.

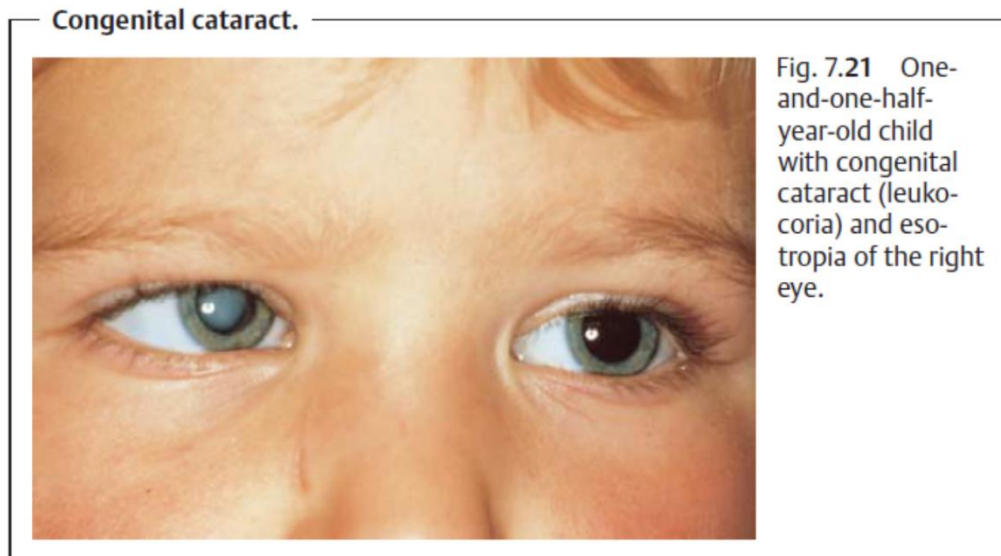
b- Others: Cytomegalovirus, Herpes simplex and Varicella.

4. Chromosomal abnormalities: a- Down syndrome (Trisomy 21). b- Other: Patau syndrome (Trisomy 13)

Treatment: We assess the density of cataract through visualization of retina. If the cataract is so dense, visualization of retina is difficult or impossible then surgery is indicated. Surgery is by lensectomy (removal of the entire cataractous lens) + anterior vitrectomy (removal of anterior surface of the vitreous just posterior to the lens) should be done with it as opacification of anterior vitreous face occur in 100% of childs after surgery. Lensectomy and anterior vitrectomy done by special machine called vitrectomy machine.

Correction of aphakia in congenital cataract:

- 1- **Unilateral aphakia:** either IOL or contact lens (NO role for glasses)
- 2- **Bilateral aphakia:** in addition to IOL and contact lens, it can be corrected by spectacles.

**Ectopia lentis**

Is refers to a displacement of the lens from its normal position.

Lense displacement is of two types:

- 1- "*Subluxated*". (**Partial dislocation**): The suspension of the lens (the zonule fibers) is slackened, and the lens is only partially within the hyaloid fossa (Fig. 7.23).
- 2- "*Luxated*" (**complete dislocation**): (complete destruction or cut of zonules).The lens is torn completely free and has migrated into the vitreous body or, less frequently, into the anterior chamber.

Causes:

1- Acquired: - Trauma. - Large eye {high myopia, buphthalmus (congenital glaucoma)}, due to stretching of zonules that causes their destruction. - Anterior uveal tumour - Hypermature cataract.

2- Congenital:

A - Without systemic association: AD, AR or associated with aniridia (congenital absence of iris).

B -With systemic association: e.g., Marfan's syndrome, Weill-Marchesani syndrome, homocystinuria, Ehlers-Danlos syndrome.

Subluxation of the lens in Marfan's syndrome.

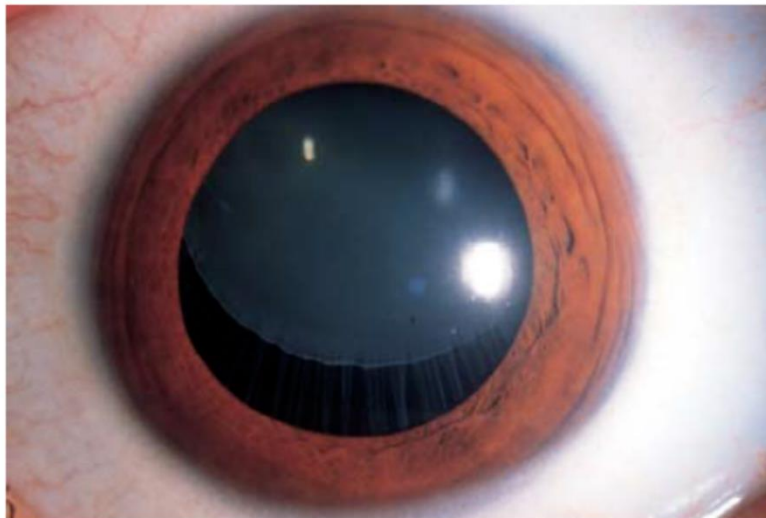


Fig. 7.23 The lens is displaced superiorly and medially. As the zonule fibers are intact, a certain measure of accommodation is still possible.

Complications of ectopia lentis:

- 1- **Refractive errors:** myopia (as the lens moves forward) and astigmatism (as the lens is tilted).
- 2- **Glaucoma:** due to pupillary block that raises the pressure inside the posterior chamber that pushes and bows the iris anteriorly "Iris bombé" and causes obstruction of the angle of the anterior chamber ending with glaucoma.
- 3- **Endothelial touch:** damage to the endothelium of cornea.
- 4- **Lens induced uveitis:** rare, occurs due leakage of lens matter to the intraocular cavities where it is regarded as foreign body, so there will be inflammatory reaction causing uveitis.

Indications of treatment:

- 1- **Refractive error:** treated by spectacles and surgery if not corrected by spectacles.
- 2- **Glaucoma:** - *If the lens is clear*, so we do YAG PI (Yttrium-Aluminum-Garnet Peripheral Iridotomy, where we create a fistula between anterior and posterior chamber through a hole at the periphery of iris). - *If there is cataract*, we do lens extraction.
- 3- **Endothelial touch** → removal of lens.
- 4- **Lens induced uveitis** (which is chronic) → removal of lens.

Mature cataract.

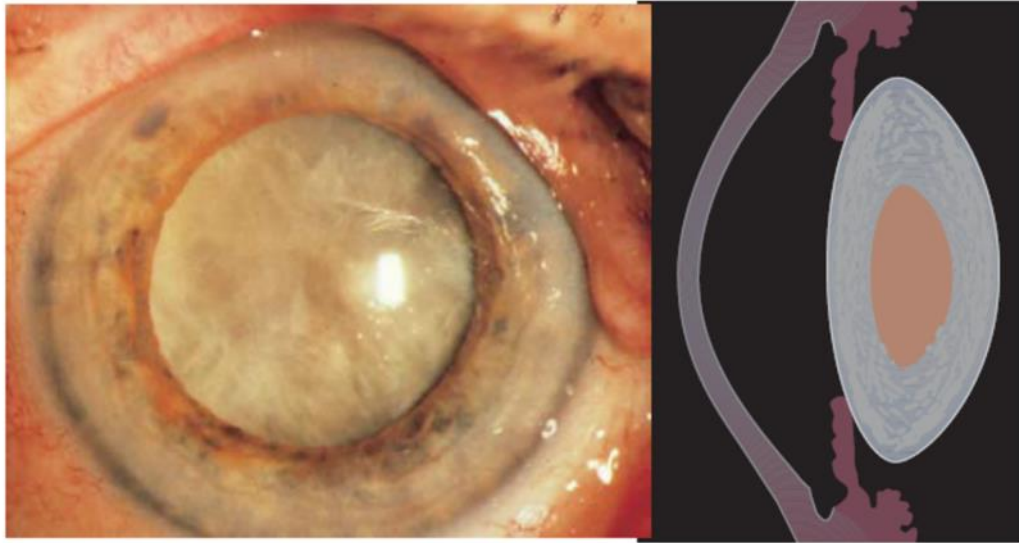


Fig. 7.9

- ❖ There is diffuse, complete opacification of the lens. A brownish nucleus is faintly visible posterior to the cortical layer.
- ❖ Interior of the eye is no longer visible.
- ❖ Visual acuity is reduced to perception of light and dark.

Hypermature cataract.

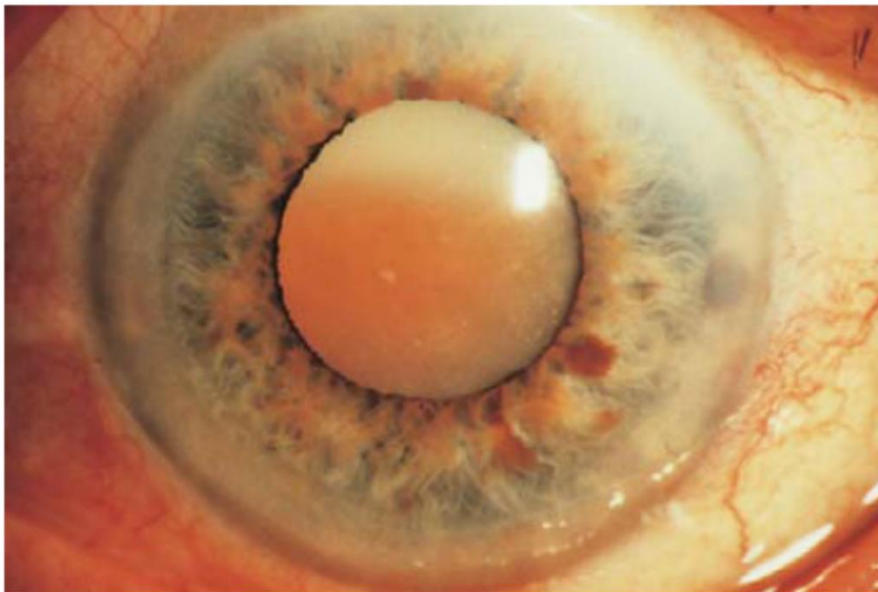


Fig. 7.10 a The brown nucleus has subsided in the liquified cortex.

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