The crystalline lens, the cataract and its surgical treatment
The crystalline lens

position:
- behind the iris
- suspended by the zonular fibers

structure:
- capsule
- cortex
- epinucleus
- nucleus

function:
- to focus clear image on retina
Development of the human lens

- origin: ectodermal
- the surface ectodermal plate thickens to form a lens placode (precursor of the lens, at 25th gestation day)
- the capsule closes the proteins of the lens from the immune system
- lens proteins can induce autoimmune reaction (trauma)

Disorders of the lens

1. position (ectopia lentis)
   - primer, ocular:
     - congenital
     - buphthalmos
     - traumatic
     - exfoliation
   - systemic:
     - Marfan syndrome
     - Weill-Marchesani syndrome
     - Homocystinuria
     - Ehlers-Danlos syndrome

2. size
   - microlentis

3. shape
   - spherophakia
   - coloboma

4. transparency

Cataract

- the water and protein components of the crystalline lens is changing (age, drugs...)
  - degeneration and opacification of lens fibres
  - formation of aberrant fibres
  - deposition of other material in the lens
  - disorganization of the lens fibres
- cataract: visible opacification of the lens
- in greek: „waterfall“, cataract patients can see like through a waterfall
Risk factors of cataract

- age:
  - 65-75 years: 50% of the population is affected
  - above 75 years: the quality of life is decreased by cataract in 70%
- diabetes mellitus
- obesity, smoking, alcoholism
- corticosteroids
- injuries, traumas
  - blunt: after months/years of injuries (sport, accident)
  - perforating trauma: immediately after capsular rupture
- glaucoma (mostly closed angle glaucoma)
- recurrent iridocyclitis (because of the inflammation and the steroid treatment)
- long term exposition of UV light
- congenital infections: herpes, rubeola
Types of cataract I.

stationer:
  • congenital
  • intrauterine:
    • rubeola
    • toxoplasma
    • cytomegalovirus
    • parotitis epidemica (mumps)
    • morbili
    • intrauterin steroid treatment/radiation

progressive = acquired:
  • presenile and senile
  • diabetic, traumatic, pharmacological-induced
Types of cataract

Laterality:
- unilateral (injuries)
- bilateral (age/drug-related), mostly with assymetrical developing

Maturity:
- immature: with good red reflex
- mature: diminished red reflex
- hypermature: no red reflex

Localisation:
- posterior subcapsular - diabetes, steroids, inflammatory diseases, injuries, at younger age
- anterior subcapsular: after blunt injuries
- cortical and nuclear: older age, excess UV exposition
Central posterior cortical cataract after steroid medications
Total cataract after uveitis (with posterior synechia)
Morgagni cataract: liquified cortex, the nucleus is sinking inside the lens capsule
Congenital cataract; surgery: as soon as possible, against amblyopia
Congenital rubeola cataract
Leucocoria (white pupil): congenital cataract (differential diagnosis!)
Anterior and posterior cortical cataract
• upward subluxation and cataract formation in Marfan syndrome: elongated zonular fibers
• downward subluxation and cataract formation:
  • in Weill-Marhesani syndrome (+spherophakia)
  • homocystinuria
lenticonus anterior and posterior:
congenital, usually unilateral
Alport syndrome: anterior lenticonus (+nephritis and hearing loss)
Symptoms of cataract

- slowly decreasing visual acuity
- blurring vision
- dimming and fading of colors
- poor/bad night vision
- visual problems in sunlight (glare)
- double vision (can be unilateral)
- myopic shift: improving near vision
- the patients go to an optician/optometrist for glass prescription
Secondary findings of cataract

- complications of cataract

- secondary glaucoma:
  - angle closure due to swelling of the
  - phacolytic glaucoma and lens induced uveitis in hypermature cataract
- anaphylactic reaction by the products of hypermaturity
- subluxation and dislocation of hypermature cataract
Diagnosis

- visual acuity test
- slit-lamp examination:
  - transparency of the lens
  - position of the lens
  - examination after dilating pupil
Treatment

Indication for surgical treatment:

1. if the patients is in trouble with their vision in everyday’s regular life
2. visual acuity decreasing is cataract-related
3. if secondary complication is presented (uveitis, glaucoma)
History of cataract surgery I.

- B.C. 2150: Hammurapi’s law mentioned „reclination of the lens”
- B.C. 600: India: reclination of lens was the common procedure
- 1745-: removing of the cataract
History of cataract surgery II.

- 1917: Barraquer – phacoeresis
- 11.29.1949: Sir Harold Ridley: first IOL implantation
- 1965: Charles Kelman: first phacoemulsification
**Anaesthesia**

- **systemic** = narcosis:
  - infants
  - poor cooperation

- **local**:
  - *retrobulbar*: injection through the eyelid to the retrobulbar muscle cone – total motorious and sensorious block
  - *peribulbar*
  - *topical*: eyedrops to the surface (and Lidocain to the anterior chamber)
Types of surgery

- "large incision", with suture:
  - ICCE: intracapsular cataract extraction: with capsule
  - ECCE: extracapsular cataract extraction: without capsule

- "small incision", without suture:
  - phacoemulsification
ICCE

• the whole lens is removed by a cryo-tip through a large incision
• today: only in cases of severe subluxation of the cataractous lens
ECCE

- large incision
- opening the capsule
- removing of the lens manually in one piece (expression)
- the posterior capsule remains intact
- rigid intraocular lens is implanted in the capsular bag
- wound is sutured
Phacoemulsification

- today's modern cataract operation
- clear corneal, small incision (<3.0 mm)
- closed system, relative high pressure in the eye
- nucleus fragmentation in the capsular bag
- using of high vacuum and ultrasound energy
- implantation of foldable intraocular lens with a cartridge system
- fast wound healing and visual rehabilitation
- possibility of one-day surgery
Phacoemulsification

Clear corneal small incision, CCC, hydrodissection, nucleus breaking into pieces, phacoemulsification of the nucleus pieces, aspiration of the cortex, implantation of IOL
Intraocular lenses

**anterior chamber lens (ACL)**

Between the cornea and iris:
after zonulolysis or trauma

**posterior chamber lens (PCL)**

in the capsular bag
Intraocular lenses

Anterior chamber lenses (ACL):

- after posterior capsule rupture, if there is no enough lens capsule to hold the IOL

- disadvantages:
  - chronic trauma of the iris
  - development of secondary glaucoma
  - damage of the corneal endothelium
Intraocular lenses

Posterior chamber lens (PCL):

- monofocal
- multifocal (FDA: 1997-)
- accommodative

Optic:

- spherical
- aspherical
- blue light blocking (to save RPE)
Planning of diopter of the IOLs

• planning the diopter of the IOL = „biometry”
• keratometry: to measure corneal curvature
• axial length measurement:
  • ultrasound
  • laser interferometry
• mathematical formulas to calculate the diopter of the IOL
Surgical complications

Intraoperative:

- chorioideal bleeding (can be severe suprachorioideal bleeding – loss of vision)
- iris injuries, iris bleeding
- rupture of the posterior capsule: prolapsus of the vitreous body
- vitreous loss: increased risk of retinal detachment
- lens material sinks to the vitreous cavity (dropped nucleus - vitrectomy)

Postoperative:

- wound dehiscence (leaking)
- endophthalmitis: purulent inflammation of the vitreous cavity (and anterior segment)
- transitional increasing of the intraocular pressure
- retinal detachment (decreasing VA)
- macular oedema (decreasing VA)
- ptosis of the eyelid (retrobulbar anaesthesia)
Endophthalmitis

- severe intraocular inflammation
- prevalence < 5 of 10000
- vision-threatening
- 3-5 days after surgery
- pain, redness, visual loss
- therapy: antibiotics and surgery
Secondary cataract

- months or years after cataract surgery
- sign: decreasing visual acuity
- reason: lens epithelial cells growing in the capsular surface
- outcome: thickening of the capsule
- treatment: YAG laser capsulotomy
Outcome of cataract surgery

- one of the most frequent surgical procedure
- high success rate, rare complications
- good surgical outcome >95% (=no serious complication and significantly improved visual acuity)
- visual acuity is influenced by retinal diseases (diabetic retinopathy, AMD…)

Take home messages

• cataract is the opacification of the crystalline lens
• the treatment of cataract is surgical
• indication is individual
• during surgery the opacified lens is removed and an intraocular lens is implanted
• after surgery, perfect visual acuity is expected if the retina, the optic nerve and the cortex is healthy