Cataract

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Outline

- Classification and types of cataract
- Etiology
- Work-up for patients
- History of cataract operations
- Trends in cataract surgery
- Operation techniques with movies
- Cataract and AMD or retinal detachment
- Types of IOL
- Wet lab

Cataract

= any opacity of the normally clear lens

Symptoms:
- slowly progressive visual loss or blurring, usually over months to years
- glare, particularly from oncoming headlights while driving at night
- reduced color perception
- the patient may be found to be more myopic than previously

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Localization of cataract

Nuclear opacity – yellow or brown discoloration of the central part of the lens

Cataracta nuclearis

Slitlamp examination

Cortical cataract – radial or spokelike opacities in the lens periphery

- often asymptomatic until the changes develop centrally
  Cataracta corticalis anterior / posterior

Localization of cataract
Localization of cataract

Posterior subcapsular cataract – opacities appear at the posterior aspect of the lens, often forming a plaque.

Cataracta subcapsularis

May be associated with:

- ocular inflammation
- prolonged steroid use
- diabetes
- trauma or radiation
- classically in patients under 50 years

Secondary cataracts

Classification (terminology) of lens opacities

Severity of cataract

- Cataracta incipiens
- Cataracta provecta (advanced cataract)
- Cataracta praematura
- Cataracta matura
- Cataracta hypermatura → the nucleus sinks downward inside the white liquefied cortical material in the capsular sac
- Cataracta intumescentis → swelling of the lens
Degree of cataract
Mature cataract – is defined as anterior cortical changes sufficiently dense to totally obscure the view of the posterior lens and posterior segment of the eye

Classification (terminology) of lens opacities

Time of manifestation

- Cataracta congenita
- Cataracta präsenilis (adults under 40 years)
- Cataracta senilis

Cataract - Etiology

- Age-related – Cataracta senilis = more than 90% of all cataracts
- Trauma:
  - Contusion
  - Penetrating eye injury
- Systemic diseases
  - Diabetes
- Other ocular diseases – Cataracta complicata
  - Chronic uveitis, exophthalmos, buphthalmos, other
  - Tumors (anterior choroidal melanoma)
  - Degenerative conditions: retinal pigmentosa
  - Multifocal macular degeneration (Peters' anomaly), senile, other
- Acute angle-closure glaucoma (“Glaukomflecken”)
- After Ocular surgery
  - Pars-plana-vitrectomy
  - Fistulating operations
  - Peripheral iridectomy
- Syndromes
  - Trisomy 13, 18 and 21
  - Turner syndrome, Lowe syndrome, Alport syndrome, other
- Medications:
  - Steroids
  - Statins
  - Certain cytostatics
- Radiation: X-ray, UV light, infrared rays (“glassblower’s cataract”)
Cataracta traumatica

Perforation of the capsular sac leads to local loss of transparency due to swelling of the lens material.

Cataracta traumatica

Rosettelike opacities – subcapsular opacities

Anterior cataracta traumatica – 5 days after Contusio bulbi – V.A. 0,63

Cataract - Etiology

General diseases:
- Metabolic disorders
  - Diabetes • the juvenile form is characterized by white “snow flake” opacities in the anterior and posterior subcapsular location
  - adults often develop age-related cataracts at an earlier stage
  - Hypocalcemia • small white cortical changes in the present of tetany
  - Galactosemia, Fabry disease
  - Myotonic dystrophy (Curschmann-Steinert disease)
    - multicoloured opacities behind the anterior capsule
- Circulatory disorders
  - Ischemic ophthalmopathy, pulsless disease (Takayasu disease)
- Skin diseases
  - Atopic dermatitis
Cataract - Work up

1. History:
   - Medications?
   - Systemic disease?
   - Trauma?
   - Ocular disease?
   - Poor vision- amblyopia before the cataract developed?

2. Complete ocular examination:
   - distance and near vision
   - refraction
   - dilated slit-lamp examination using both direct and retroillumination
     techniques to properly view the cataract. Fundus examination of the
     macula is essential in ruling out other causes of decreased vision
   - B-scan-ultrasound in a dense cataract when fundus is obscured
   - IOL- calculation, biometry
   - keratometry
   - evaluation of the corneal endothelium

Work up

Determine the etiology!

- Is the cataract responsible for the decreased vision?
- Would surgical removal improve vision?

Cataract surgery may be performed:

- to improve visual function in patients with symptomatic visual disability
- as therapy of ocular disease (lens-related glaucoma)
- to facilitate management of ocular disease (monitor or treat diabetic retinopathy, vitrectomy in severe retinal detachment)

→ correct any refractive error if the patient declines cataract surgery
→ patients who decline surgical removal are re-examined yearly, sooner if there is a symptomatic decrease in visual acuity
History of cataract operation

„Starstich“ - 17. century

Technic of the „Starstich“

Intracapsular Cataract-Extraction - ICCE

History of cataract operation
History of cataract operation

Extracapsular cataract extraction - ECCE

- 2 - 3 mm Clear Cornea incision temporal or superior
- Phakoemulsifikation
- topical anaesthesia
- bimanuell suction
- polishing of the posterior capsula
- Injector implantation of foldable IOLs
- No stitch - technic
European Cataract Outcome Study - ECOS (ESCRS sponsored)

- shows a continuing shift to outpatient surgery, use of foldable IOLs and topical anaesthesia.
- Surgical complications are sinking, they are about 3.0 – 3.5 per cent.
- Posterior capsule rupture rates reached 1.2 per cent.
- The vitreous loss rate was 0.8 per cent.

European Cataract Outcome Study

- Surgical complications were higher in more difficult eyes.
- Factors that might complicate surgery:
  - white cataract 3.1 per cent
  - small pupil 2.9
  - Pseudoexfoliation PEX 5.7
  - corneal opacities 2.2
  - previous refractive surgeries 0.15
- One in 200 cataract operations ends up with unexpected aphakia.

Pseudoexfoliation - PEX
Pseudoexfoliation - PEX

Pseudoexfoliation syndrome (PEX) is a systemic fibrillopathy affecting a wide range of tissue, which in the eye involves the lens, zonule, ciliary body, iris and drainage angle.

- PEX-deposits
- rapidly progressive open-angle glaucoma
- phacodonesis, subluxation of the lens
- pseudouveitis
- PEX-keratopathy (endotheldekompensation)

- cave cataractoperation:
  - Mydriasis -> often small pupil
  - Dropping of the nucleus (Zonulolysis)
  - Fibrinreaction postoperatively

Drop anaesthesia

**Advantage:**
- No painful injection
- No touch Phako
- Anticoagulation doesn't need to be stopped
  - Early visual rehabilitation

**Disadvantage:**
- Adrenalinlevel of the surgeon
- Compliance of the patient

Operation technic

Incisionsize / Phaco-tunnel

- Trauma
- Inflammation
- Risk of Infection
- Astigmatism
- Recovery
Capsulorhexis

Operation technic

Circular opening of the anterior lens capsule with a curved needle

Hydrodissection and Hydrodeliniation

Phacoemulsification with Chopper

Operation technic

Ultrasonic destruction of the lens nucleus in the capsular sac
### Phako Chop

**Advantage**
- Prechopping reduces phakotome
  - Hard nucleus
- Less zonulastress → PEX eyes
  - Phako in patients with hard nucleus is possible instead of ECCE

**Disadvantage**
- Learning curve
- Rupture of the capsule

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### Cataract surgery in small pupils

**Operation technique**
- Malyugin ring
  - Expansion devices
  - Pupil stretching: 4 iris hooks
Cataract surgery in difficult eyes

Pupil stretching

A pair of hooks (push-pull) is introduced through 2 incisions in the cornea and used to mechanically stretch the iris.

The hooks engage the iris sphincter and are pulled in opposite directions, resulting in one or more tears of the sphincter, which leads to an enlargement of the pupil aperture.

**Advantage**
- easy operation on small pupils

**Disadvantage**
- rupture of iris sphincter
- bleeding
- fibrin reaction

Cataract surgery in eyes with small pupils

- Pseudoxfoliation (PEX)
- Diabetes
- Uveitis
- Glaucoma

Pupil stretching
Cataract surgery in difficult eyes
eyes with mature cataract

• Use Vision blue for the capsulorhexis

Vision blue for mature cataract

Traumatic cataract
Postoperative care

- ophthalmological examination on the first postoperative day and then weekly
- avoid direct pressure to the eye
- local therapy until signs of inflammation have subsided
- fitting of new glasses after 4 - 6 weeks

Complications of cataract surgery

Intraoperative:

- Radial tear of the capsulorhexis
- Rupture of the posterior lens capsule (incidence 1 – 3%)
  - vitreous prolapse → anterior vitrectomy
- Injury to the iris by phaco handpiece
- Massive hemorrhage / explosive hemorrhage (very rare)
- Tear of Descemet’s membrane
- Corneal burn

Complications of cataract surgery

Postoperative:

<table>
<thead>
<tr>
<th>Common</th>
<th>Incidence</th>
<th>Vision Threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Capsular Opacification</td>
<td>10-30%</td>
<td>Retinal Detachment</td>
</tr>
<tr>
<td>Cystoid Macular Edema (transient)</td>
<td>2-10%</td>
<td>1-2%</td>
</tr>
<tr>
<td>Vitreous Loss</td>
<td>1-5%</td>
<td>IOL Malposition</td>
</tr>
<tr>
<td>Cystoid Macular Edema (persistent)</td>
<td>4-10%</td>
<td>Endophthalmitis</td>
</tr>
<tr>
<td>Corneal Endothelial Cell Loss</td>
<td>0.3%</td>
<td>Increase in ocular pressure</td>
</tr>
<tr>
<td>Cystoid Macular Edema (persistent)</td>
<td>1-2%</td>
<td>Endophthalmitis</td>
</tr>
<tr>
<td>Astigmatism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trapping of the iris in the wound with irregularity of the pupil</td>
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</table>
Association between cataract and late AMD?

- AREDS: There is no significant association between cataract surgery at baseline and the development of either geographic atrophy or wet AMD.
- In wet AMD combination with anti-VEGF-injections

Risk of retinal detachment (RD) after cataract surgery?

Retrospective study of 10,256 cataract surgeries in 7,137 residents of Olmsted County, Minnesota from 1980 to 2004 (Ophthalmology 2006; 113: 2026-2032)

- At 20 years after cataract surgery the cumulative risk of RD remained 4 times higher than would be expected in a comparable group who did not have cataract surgery
- There was no significant difference in the probability of RD after ECCE when compared with phacoemulsification
- Myopia, increased axial length, younger age (40 years old) and posterior capsular tear at surgery were associated with an increased risk of pseudophakic RD
  - Patient at high risk: the young men with “Clear-Lens-Extraction” due to high myopia
  - Risk of RD is highest within the first 6 months after cataract operation

Phaco for glaucoma

- Early cataract surgery can be a great option for patients with mild to moderate glaucoma who have demonstrated less than ideal IOP control with standard medical treatment.
- Clear corneal temporal phacoemulsification appears to lower intraocular pressure approximately 4.0 mmHg for at least 3 years. The case appears to be even stronger for patients with PEX.
1949: Without IOL calculation, implantation of a 24 dpt IOL in the capsular bag
Postoperative refraction: -18.0 – 6.0/120°
Iris fixt IOL  
Generation III (1953 – 1973)

Anterior chamber lens  
Generation IV (1963 – 1992)

Generation VI- Foldable lens

Clinical appearance of an IOL one day after cataract operation, the round opening in the anterior lens capsule can be seen and the anterior capsule should cover the IOL 360°
Foldable lens- Injector technic
AcrySof Singlepiece SA60AT
Monarch II injector A-cartridge

Implantation of foldable lens

Types of IOL
yellow IOL
AcrySof Natural
- contains a blue light-filtering chromophore
- provides light protection beyond traditional ultraviolet protection (Standard IOL).
- designed to filter both invisible ultraviolet rays and visible blue rays of light.
Why a yellow IOL?

-While the traditional lens provide light filtration from 200-400 nm, the AcrySof Natural lens would provide filtration properties from 200-550 nm.
-Extended exposure to visible blue light rays are widely considered to be a causative factor for damage to the retina and macula and are believed to cause AMD.

An IOL with an incorporated blue light blocker mimics the protection provided by the natural crystalline lens to the retina.
Spharic Aberration of the natural crystalline lens

The cornea has positive spherical aberration, which means peripheral rays are focused in front of the retina. This positive spherical aberration of the cornea remains throughout life. In young people, the natural lens corrects this defect, as it is dominated by negative spherical aberration. However, the natural lens undergoes changes with age, which cause a shift of spherical aberration towards positive. This adds to the positive spherical aberration of the cornea with possible increased sensitivity to glare and also reduced appreciation of contrast.

So what about astigmatism?

How do we treat it?

Typs of IOL

Toric IOL

AcrySof® IQ Toric IOL offers cataract surgery in patients with astigmatism:
- Reduction of residual refractive cylinder
- Improved uncorrected distance visual acuity
- Increased spectacle-independent distance vision

- Approximately 60% of unilateral patients implanted achieved spectacle-independent distance vision.
Rotational Stability

IOL rotation can have significant impact on astigmatism correction.

- Generally, for every 1º of IOL rotation, 3.3% of lens cylinder power is lost.1
- A complete loss of cylinder power can occur with a rotation of >30º.1

Monofocal intraocular lenses (IOL)

Characteristics:
- Uniform refraction power like 21.5 dpt.
- Beams of light are bundled in one focus point.
- Surgeon corrects either distance or near vision.
- Postoperatively patients need glasses for near or distance vision.
Types of IOL

Multifocal IOL

Goal:
Allows functional distance and near vision independent from additional correction (spectacle) using the principle of simultaneous vision. Incoming light is divided between 2 lens powers, one for distance vision and one for near vision.

Function of multifocal IOL

- Distance vision
When one views a distant object, the image from the near power is greatly defocused and very faint, so only the object in the distance is seen

- Near vision

Binocular defocuscurve

Types of IOL

- Computer
- Golf
- Multifocal IOL
- Monofocal IOL
Binocular Defocus Curve
+4.0D vs. +3.0D

Types of IOL

Patient selection for multifocal IOL

- diversified function / job
- no varifocals
- excellent biometry
- ≤ 1.0 D of astigmatism preoperatively
- aim → bilateral implantation
- adaption phase
- additional glasses for computer working

Mono-vision „Goetheblick“

- The dominant eye is corrected to emmetropia
- The fellow eye is corrected to myopia (-0.75 to -2.25 dpt)

• the dominant eye is corrected to emmetropia
• the fellow eye is corrected to myopia (-0.75 to -2.25 dpt)
The Add-On concept describes one IOL located in the capsular bag and an additional Add-On IOL placed in the sulcus ciliaris.

### Types of IOL

**Add-On IOL**

The Add-On IOL is placed in the sulcus ciliaris.

### Add-On IOLs

**Advantages:**
- **Refractive “fine-tuning”** - correction of residual ametropia (spherical, cylindrical) – alternative option to Excimer Laser surgery
- Avoids risk and hazards of IOL explantation from capsular bag
- **Reversibility**
  - Useful in keratoplasty patients
  - To update pediatric IOL implants after growth of the eye
  - Power compensation after silicone oil removal

### How to avoid PCO (posterior capsular opacity)?

**Best against PCO**
- IOL with a sharp posterior optic edge, which creates a sharp bend in the posterior capsule which constitutes a barrier to lens epithelial cell migration
- Anterior capsule (capsulorhexis) overlaps the IOL’s optic 360°
- It is important not to polish the anterior capsule, since the absence of anterior lens epithelial cells will interfere with the fusion and sealing of the anterior and posterior capsule

**Worst for PCO**
- Half covered half free IOL – anterior capsule
- PCO always comes from the uncovered side.
To help optimize incision and IOL alignment, the VERION™ Image Guided System uses the VERION™ Digital Marker display patient information and images from the VERION™ Reference Unit:

- Features a tracking overlay on the microscope that enables surgeons to see all incisions and alignment in real time.
- Automatically accounts for cyclorotation.
- eliminates the need for manual toric eye markings.
- Automatically registers the patient for accurate centering and alignment of multifocal and toric IOLs.
- Allows documentation of data to help optimize procedures over time.
- Measures keratometry, pupillometry and other key pre-op parameters.

Exciting new technologies:

Inclinations

Capsulorhexis Guide
Exciting new technologies
Femtosecond laser-assisted cataract surgery

In an alternative method the nucleus is liquefied for reduction in phako power and phako time.

Capsule can be more precisely centred. Incisions in the cornea are made with precision.

Intracapsular incision allows for minimal trauma and better recovery.

Steps of cataract operation with femtolaser.