Section 1

CATARACT AND
CATARACT SURGERY
This page intentionally left blank
**TOPIC 1**

THE LENS

**Opening Question:** What is the Anatomy of the Lens?

“The lens is located between the anterior and posterior segments of the eye.”

**Anatomy of the Lens**

1. **Gross anatomy**
   - Biconvex, transparent structure that divides eye into anterior and posterior segment
   - General dimensions: 10 mm diameter, 4 mm thickness, 10 mm anterior surface radius, 6 mm posterior surface radius

2. **Microscopic anatomy**
   - Capsule
     - **Acellular** elastic structure
     - Similar to basement membrane (type 4 collagen)
     - Zonules run from ciliary processes and fuse onto outer layer of capsule
     - Main function is to mould the shape of lens in response to tension on zonules
     - Important barrier to forward migration of the vitreous during/after lens extraction
   - Anterior epithelium
     - Functionally divided into 2 zones:
       - Equatorial zone
         - Actively dividing and differentiating into lens cell fibers
       - Non-equatorial zone
   - Transports solutes between lens and aqueous humor
   - Secretes capsular material
   - All epithelial cells are nucleated
   - Cytoplasm contains organelles (ribosomes, sER, rER, GA, mitochondria)
   - Lens fibers
     - Divided into cortex and nucleus
     - Cortex
       - Suture lines (anterior Y shape, posterior inverted Y)
       - Only the young lens fibers have normal cellular organelles which subsequently disintegrates with aging
       - Newly formed cortical fibers elongate, with one end of the cell moving anteriorly and the other end posteriorly
     - Nucleus
       - Consists of cells that have been retained throughout life
       - Metabolism of cells in the nuclear region is minimal

**Exam tips:**
- Not a very common question, but considered “basic” anatomical knowledge.
- In general, anatomy questions like “What is the anatomy of...” can be answered by first dividing the structure into gross and microscopic anatomy.

**Opening Question:** What is the Function of the Lens? Why is it Transparent?

“The main functions of the lens are...”
Functions of Lens

1. Function of lens
   - Refraction
     - Accounts for 35% of total refractive power of eye (15D out of total of 58D)
     - Light transmission
   - Small differences in refractive index between components
   - Little cellular organelles
   - Little extracellular space (tight ‘ball and socket’ junctions)

2. Maintenance of transparency
   - Regular arrangement of lens fibers

What is the Embryology of the Lens?

Embryology

1. Formation of lens vesicle
   - 4 mm stage (4 weeks)
   - Optic vesicle induces lens placode from ectoderm
   - Lens placode invaginates and becomes lens pit
   - Optic vesicle also invaginates and becomes the optic cup
   - Lens pit separates from ectoderm to become lens vesicle

2. Formation of lens fibers and zonules
   - Primary lens fibers
     - Cells in posterior portion of lens vesicle elongate to fill vesicle
     - Secondary lens fibers
     - Cells in anterior portion of vesicle divide actively and elongate
     - Tertiary lens fibers
     - Cells in equatorial zone of lens epithelium divide and differentiate into long lens fibers
     - Lens zonules
     - Develop from neuroepithelium running from inner surface of ciliary body to fuse with lens capsule

How is Glucose Metabolized in the Lens?

Carbohydrate and Energy Metabolism

1. Energy production entirely dependent on glucose metabolism
   - Glucose enters lens by simple diffusion and facilitated diffusion
   - Glucose is rapidly metabolized via glycolysis so that level of free glucose in lens < 1/10 glucose in aqueous

2. 4 pathways
   - Anaerobic glycolysis
     - Accounts for 85% of glucose metabolism by lens
     - Provides > 70% of energy for lens
     - 1 mole of glucose gives 2 moles of ATP
     - Lactate generated undergoes 2 pathways of metabolism:
       - Further metabolism via Kreb’s cycle
       - Diffusion from lens into aqueous
   - Aerobic metabolism (Kreb’s cycle)
     - Limited to epithelium
     - 1 mole of glucose gives 38 moles of ATP
     - Only 3% of lens glucose metabolized by this pathway
     - But generates up to 20% of total ATP needs of lens
   - Hexosemonophosphate shunt
     - Accounts for 5% of glucose metabolism by lens
     - Important source of NADPH required for other metabolic pathways e.g. sorbitol pathway and glutathione reductase
   - Sorbitol pathway
     - Glucose → sorbitol via aldose reductase → fructose via polyol dehydrogenase
     - Accounts for 5% of glucose metabolism by lens
     - When sorbitol accumulates within cells of lens, it sets up an osmotic gradient that induces influx of water and lens swelling and ultimately loss of lens transparency

What is the Biochemical Structure of Lens Proteins?

“There are 2 types of lens proteins....”
Biochemical Structure of Lens Proteins

1. Water soluble lens crystallins
   - 90% of total lens protein
   - Alpha crystallin
     - Largest crystallin
     - Accounts for 35% of total lens protein
   - Beta crystallin
     - Most abundant crystalline; accounts for 55% of total lens protein
     - Most heterogeneous group; 4 distinct subgroups

2. Water insoluble proteins – includes:
   - Gamma crystallin
     - Smallest crystallin
     - Least abundant
   - Membrane proteins – urea insoluble
   - Cytoskeletal proteins and crystallin aggregates – urea soluble
This page intentionally left blank
**Opening Question:** What are the Causes of Cataracts?

“By far the most common cause of cataract is aging.”
“Other causes can be classified into 2 types: congenital and acquired.”

**Etiology of Cataracts**

1. **Congenital**
   - Genetic and metabolic diseases
   - Down’s syndrome, galactosemia, Lowe’s syndrome
   - Intrauterine infection
   - Rubella
   - Ocular anomalies
   - Aniridia
   - Hereditary cataract

2. **Acquired**
   - Age-related cataract
   - Traumatic cataract
   - Metabolic diseases
     - DM
     - Toxic
     - Steroid use, chlorpromazine
   - Secondary to ocular disease
     - Uveitis
     - Angle closure glaucoma (glaukomflecken)

**Exam tips:**
- In general, etiology questions like “What are the causes of...?” can be answered in a common opening statement: “The causes can be classified into congenital or acquired. Congenital causes include...”
- In other situations, it may be best to answer directly the most common cause first (which gives the impression that you’re not memorizing from the book!).
- Do not list the rare conditions. For example, under metabolic diseases, say “diabetes,” and avoid “hyperparathyroidism.”

**What is the Pathophysiology of Age-related Cataracts?**

**Pathophysiology of Age-related Cataracts**

1. **General risk factors**
   - Age
   - Smoking
   - Ultraviolet light exposure
   - Medications and other environmental exposures (controversial)

2. **Cortical cataract**
   - Usually results from derangement of electrolyte and water balance
     - Increased levels of sodium, chloride and calcium
     - Decreased levels of potassium
• Associated with marked increase in lens membrane permeability
• Associated with liquefaction of lens material and osmotic phenomena (lens intumescence)

3. Nuclear cataract
• Associated with protein modification and increased coloration (urochrome pigment)

Q What is the Pathophysiology of Diabetic Cataracts?

“There are two pathogenic mechanisms in diabetic cataracts…”

Pathophysiology of Diabetic Cataracts

1. Osmotic effect
   • Glucose $\rightarrow$ sorbitol via aldose reductase (rapid)
     $\rightarrow$ fructose via polyol dehydrogenase (slow)
   • Sorbitol cannot diffuse out of intracellular compartment $\rightarrow$ accumulates in lens $\rightarrow$ creates an osmotic gradient and movement of water into cells $\rightarrow$ swelling and rupture of cells $\rightarrow$ results in opacification and cataract formation

2. Direct damage
   • Glucose may directly interact with lens proteins via glycosylation, leading to protein aggregation and cataract formation

Q Tell me about Galactosemia.

“Galactosemia is an inborn error in metabolism.” “The inheritance is AR and there are 2 types.”

Galactosemia

1. Galactosemia (type II or classic galactosemia)
   • Pathophysiology
     • Deficiency of galactose-1-phosphate uridyl transferase (GPUT)
     • Galactose $\rightarrow$ dulcitol/galactitol via aldose reductase (no further metabolism)
     • Accumulation of dulcitol results in osmotic disturbance in lens, leading to cataract formation
   • Clinical features
     • Central oil droplet cataract
     • Nonglucose reducing substance present in urine
     • Generally sick (failure to thrive, hepatosplenomegaly, CNS disease, renal disease)

2. Galactokinase deficiency (type I)
   • Pathophysiology
     • Deficiency of galactokinase
     • Galactose $\rightarrow$ dulcitol/galactitol via aldose reductase (no further metabolism)
   • Accumulation of dulcitol results in similar pathway as in Galactosemia type II
   • Clinical features
     • Lamellar cataract (early cataract formation that sinks into lens substance with subsequent growth following institution of dietary control)
     • Generally healthy

Exam tips:
• Note that aldose reductase is important in the pathogenesis of both diabetic and galactosemic cataracts.

Q What are the Ocular Signs in Down’s Syndrome?

“The ocular features of Down’s syndrome can be divided into anterior segment and posterior segment signs.”
Down’s Syndrome

1. Inheritance
   - Nondisjunction (95%)
     - 47 chromosomes (3 chromosome 21)
     - Nonhereditary
     - Risk to siblings 1%
   - Translocation (4%)
     - 46 chromosomes (segment of chromosome 14 translocates to chromosome 21)
     - Hereditary
     - Risk to siblings 10% (with high rates of spontaneous abortion)
   - Mosaic (1%)
     - 47 chromosomes in some cells, 46 in others
     - Nonhereditary

2. Systemic features
   - Mental retardation
   - Stunted growth

3. Ocular features
   - Anterior segment
     - Lid (blepharitis, epicanthal fold, mongoloid slant)
     - Nasolacrimal duct obstruction
     - Cornea (keratoconus)
     - Iris (brushfield spots, iris atrophy)
     - Cataract
   - Posterior segment
     - Increased retinal vessels across optic disc
   - Others
     - High myopia
     - Strabismus, nystagmus and amblyopia
     - Macular hypoplasia

Exam tips:
- Questions like “What are the ocular signs of…?” can be answered with a common opening statement, “The ocular signs can be divided into anterior segment or posterior segment signs. Anterior segment signs include….”
- You may consider either answering directly the commonest eye sign first, “The commonest ocular feature is….”
- Or answering the most important eye sign first: “The most important eye sign is….”
TOPIC 3

CONGENITAL CATARACTS

Opening Question No. 1: What are the Causes of Congenital Cataracts?

“Congenital cataracts can be classified into 2 types: primary and secondary.”
“Secondary causes include….”

Classification of Congenital Cataract

1. Primary
   - Idiopathic (50% of all congenital cataracts)
   - Hereditary (30%, usually AD)
2. Secondary
   - Systemic disorders
     - Chromosomal disorders (Down’s syndrome)
     - Metabolic disorders (galactosemia, Lowe’s syndrome)
   - Maternal infections (toxoplasmosis)
   - Ocular developmental disorders
   - Persistent hyperplastic primary vitreous
   - Anterior segment dysgenesis, aniridia
   - Congenital ectropian uvea, nanophthalmos
   - Ocular diseases
   - Trauma, uveitis, retinoblastoma

Exam tips:
- Do not list the rare causes of congenital cataract. For example, remember “galactosemia” but avoid “Alport’s syndrome” (unless you know it well!)
- The classification is identical to that of congenital glaucoma (see page 57) and subluxed lens (see page 35).

Opening Question No. 2: How do You Manage Congenital Cataracts?

“The management of congenital cataract is difficult.”
“And involves a multidisciplinary team approach.”
“The important issues are….”
“And factors that will influence the decisions include….”
“The management consists of a thorough history….”

Management of Congenital Cataracts

1. Important issues (see below for detailed discussion)
   - Indications for cataract extraction
   - Timing of surgery
   - Type of surgery
   - Aphakic correction
2. Factors that influence the decisions
   - Cataract factors (type of cataract, location of cataract, severity of cataract, unilateral or bilateral cataract)
   - Child factors (age of onset, associated systemic diseases)
• Parent factors (motivation of amblyopia correction)

3. History
• Age of presentation
• Unilateral/bilateral
• Family history (AD, AR, etc), consanguinity
• Birth history – Low birth weight (ROP), trauma at birth (cataract)?
• Maternal infection?
• Drug exposure?
  • Naphthalene, phenothiazines, steroids, sulphonamides
• Radiation exposure?

4. Clinical examination
• Visual acuity
  • Forced preferential looking charts (hundreds and thousands), Catford drum, optokinetic drum
  • Kay picture chart, Sheridan Gardiner, illiterate “E”
• Lens opacity
  • Location
    • Polar, subcortical, cortical, lamellar, total
  • Type
    • Spoke-like (Fabry’s disease, mannosidosis)
    • Vacuoles (DM, hyperalimentation, ROP)
    • Multi-color flecks (hypoparathyroidism, myotonic dystrophy)
    • Oil droplet (galactosemia, Alport’s syndrome)
    • Thin, wafer-shaped (Lowe’s syndrome)
    • Green sunflower (Wilson’s disease)
• Associated ocular anomalies
  • Anterior segment
    • Microophthalmos (rubella)
    • Megalocornea, sclerocornea, keratoconus
    • Cloudy cornea (Peter’s plus syndrome, Lowe’s syndrome, Fabry’s disease, glaucoma)
    • Uveitis (juvenile rheumatoid arthritis)
    • Aniridia, mesenchymal dysgenesis, coloboma
    • Glaucoma (aniridia, Peter’s plus syndrome, Lowe’s syndrome, rubella, trisomy 18)
  • Posterior segment
    • Vitreous strands (persistent fetal vasculature, Stickler’s syndrome)
    • Retinal abnormalities
      • ROP, retinoblastaoma,
      • Pigmentation (rubella, Bardet-Biedl syndrome, Refsum’s disease)
      • Atrophy (Cockayne’s syndrome)
      • White flecks (Alport’s syndrome)
    • Optic nerve abnormalities
  • Associated systemic anomalies
    • Chromosomal (Down’s syndrome and others)
    • Skin rash (atopic dermatitis)
    • Deafness (Alport’s syndrome, Rubella, Refsum’s disease)
    • Hepatic dysfunction (Wilson’s disease, Zellweger’s syndrome)
    • Renal disease (Lowe, Alport’s, Zellweger’s syndrome)
    • CNS disease (Zellweger’s syndrome, Lowe)

5. Investigations
• Serum
  • Complete blood count
  • Renal function tests, serum calcium (hypoparathyroidism)
  • Serology for virus (toxoplasmosis)
  • GPUT and galactokinase activity in red blood cells (galactosemia)
  • Arterial blood gas (Lowe’s syndrome)
• Urine
  • Reducing substance (galactosemia)
  • Amino acid (Lowe’s syndrome)
  • Sediments (Fabry’s disease)
  • Copper (Wilson’s disease)
  • Blood (Alport’s syndrome)
• SXR for calcifications (toxoplasmosis, hypoparathyroidism)
• Others
  • Karyotyping (chromosomal disorders)
  • Cultured fibroblasts with low mannosidase level (mannosidosis)
  • Conjunctival biopsy with birefringent cell inclusions (Fabry’s disease)
  • Audiological evaluation

Exam tips:
• This is a difficult question to answer. Provide a precise opening statement to capture the gist of problem.
• The issues are important and must be addressed.
• The factors that help in addressing the issues are derived from the history and examination.
Important Issues in Cataract Management

1. Indications for surgery
   - “Severe” cataract
     - Frequent assessment of visual function needed
     - In general, operate when cataract is severe enough to affect visual function and development of the eye
     - Earlier surgery indicated when cataract is unilateral (more amblyogenic)
   - Common indications — cataract is associated with:
     - Compromised fixation (infants)
     - Snellen VA or equivalent VA < 6/24 (older baby)
     - Strabismus
     - Poor visualization of fundus
     - Opacity occupying central 3 mm

2. Timing of surgery
   - Depends on laterality and severity
   - Bilateral severe
     - < 2–3 months
     - Operate fellow eye within 1 week of first operation
   - Unilateral severe
     - < 4 months (best outcomes when performed < 16 weeks)
     - If persistent hyperplastic primary vitreous present, consider operating earlier
     - After 9 years of age, operate for cosmetic results only
   - Bilateral or unilateral mild
   - May consider waiting until child is older

3. Type of surgery
   - “What are the problems associated with congenital cataract surgery?”
     - Intraoperative problems
       - Risk of GA (prematurity, systemic diseases)
       - Small eye
       - Hard to dilate pupil
       - Low scleral rigidity
       - Solid vitreous
       - Elastic anterior capsule
     - Postoperative problems
       - Higher incidence of posterior capsule opacification
       - Increased inflammation
       - IOL decentration
       - Difficulty in refraction
       - Refractive correction and amblyopia treatment
     - Standard technique is usually combination of:
       - Lens aspiration/lensectomy
     - Primary posterior capsulotomy
     - Anterior vitrectomy: At least 1/3 of anterior vitreous must be removed
     - May be either corneal/transpupillary or pars plana approach
     - IOL material: Single piece PMMA lens has longest safety record, acrylic foldable lenses increasingly utilized
     - IOL frequently captured in posterior CCC to improve centration and block vitreous migration
     - Additional considerations
       - < 18 months (corneal 2-stab incision lensectomy, 1 for AC maintainer, 1 for ocutome/vitrector)
       - 18–24 months (scleral tunnel lensectomy, with phacotome)

4. Aphakic correction
   - Depends on laterality and age
   - IOL implantation
     - Indication: unilateral aphakia in children 6 months to 1 year or older (not indicated for children < 6 months)
     - Biometry done under GA prior to operation
     - “How do you choose the IOL power?”
       - Difficult to estimate because of the progressive myopic shift with age (axial length of 16.8 mm at birth, this space becomes 20 mm by 1 year)
     - 5 different approaches
       - Preferred approach: Undercorrecting eye by 1–4D from IOL power that is calculated for emmetropia based on age of child (aim for initial hypermetropia)
       - IOL based on emmetropia
       - IOL that matches refractive error of fellow eye
       - IOL based on axial length alone
       - IOL of 21–22D in all normal sized eyes in children more than 12 months old
   - Aphakic glasses
     - Indication: Bilateral aphakia in older child
   - Contact lens
     - Indication:
       - bilateral or unilateral aphakia in infants
       - frequently needed for correction of anisometropia after IOL implantation in very young children/infants
     - Family support/compliance essential
     - Extended wear soft lens
       - Keratometry under GA
       - Lens diameter of 13.5
       - Overcorrect by 2.5–3D (near vision more important to prevent amblyopia)
     - Infantile Aphakia Treatment Study (in progress)
• Background:
  - IOL use for correction of infantile aphakia still controversial due to problems with IOL power selection and safety concerns
  - Two-thirds of aphakic infants treated with contact lenses remain legally blind in the aphakic eye

• Aim: To compare the use of contact lenses and IOL implantation in the correction of unilateral aphakia
• Study groups: Infants up to 7 months of age with unilateral cataracts randomized to cataract surgery with IOL vs contact lens correction
TOPIC 4

CATARACT SURGERY

Opening Question: What are the Types of Cataract Surgery?

“There are 3 basic types of cataract surgery.”

Cataract Surgery
1. Intracapsular cataract extraction (ICCE)
2. Extracapsular cataract extraction (ECCE)
3. Phacoemulsification

Advantages of ECCE over ICCE
1. Smaller wound size
   - Faster healing time
   - Fewer wound problems (wound leak and iris prolapse)
   - Less astigmatism
   - Less risk of iris incarceration
2. No vitreous in AC
   - Lower risk of bullous keratopathy

Advantages of ECCE over ICCE
1. Lower risk of cystoid macular edema
2. Lower risk of retinal detachment
3. Lower risk of glaucoma

3. Intact posterior capsule
   - PC IOL implantation possible
   - Eliminate complications associated with AC IOL

What are the Advantages (and Disadvantages) of Phacoemulsification over ECCE?

Phacoemulsification vs ECCE
1. Advantages
   - Smaller wound size
   - Faster healing time
   - Fewer wound problems (wound leak and iris prolapse)
   - Less astigmatism

   - Less risk of expulsive hemorrhage
   - Operation can be performed under topical anesthesia
   - Conjunctival sparing (important in patients with glaucoma)
2. Disadvantages
   - Machine dependent
   - Longer learning curve
   - Higher complication rate during learning curve

Q How do you Perform an Extracapsular Cataract Extraction?

“I would perform an extracapsular cataract extraction with IOL implantation as follows...”

**ECCE with IOL**

1. **Preparation**
   - Retrobulbar or peribulbar anesthesia
   - Superior rectus suture with 4/0 silk

2. **Conjunctival peritomy**

3. **Partial thickness limbal incision**
   - 2-plane technique (vertical and horizontal)
   - Vertical component made with Beaver blade to 2/3 of scleral thickness, from 10–2 o’clock

4. **Anterior capsulotomy**
   - Enter AC with 27 G needle
   - Fill AC with viscoelastic
   - Perform anterior capsulotomy using “tin can” technique

5. **Nucleus expression**
   - Complete horizontal component of the limbal incision with scissors

   **Exam tips:**
   - When asked about a certain surgical technique, describe what you are familiar with and make your own notes.
   - Be prepared to answer further questions related to the procedure you choose.
   - Be concise but accurate with the steps, as if you had done the procedure a hundred times. Say, “I will make a 2-plane limbal incision from 10 to 2 o’clock with a beaver blade” rather than “I will make an incision at the limbus.”
   - Avoid abbreviations. Say “extracapsular cataract extraction” instead of “ECCE.”

Q What are Some Potential Problems with Anterior Capsulotomy and Nucleus Expression During ECCE?

**Anterior Capsulotomy and Nucleus Expression**

1. Problems with anterior capsulotomy
   - Zonulolysis
   - Endothelium damage
   - Miosis
   - Loss of aqueous (AC shallowing)

2. Problems with nucleus expression
   - Wound too small (PCR)
   - Incomplete capsulotomy (PCR)
   - Difficult to express nucleus in soft eye
   - Sphincter rupture with small pupil
   - Tumbling of nucleus (endothelium damage)

Q How do you Perform an Intracapsular Cataract Extraction?

“Currently, the only common indication for planned ICCE is a subluxed lens.”

“I would perform an intracapsular cataract extraction with IOL implantation as follows...”
ICCE with AC IOL

1. Preparation
   - Retrobulbar or peribulbar anesthesia
   - Superior rectus suture with 4/0 silk
2. Conjunctival peritomy
3. Full thickness limbal incision with Beaver blade and complete incision with scissors, from 9–3 o’clock (larger than ECCE)
4. Peripheral iridectomy with Vanna scissors
5. Lens removal
   - Dry lens with Weck sponge
   - Apply cryoprobe between iris and cornea onto lens
   - Alternatively, use vectis and forceps to remove lens
6. AC IOL implantation
   - Constrict pupil
   - Reform AC with viscoelastics
   - Insert AC IOL with help of lens glide
7. Wound closure
   - 10/0 nylon sutures
   - Subconjunctival steroid/antibiotic injection

Q How do You Perform Phacoemulsification?

Phacoemulsification

1. Preparation
   - Retrobulbar, peribulbar or topical anesthesia
2. Clear corneal tunnel
   - Stab incision with 2.5 mm keratome for main wound at 12 o’clock
   - Stab incision with Beaver blade for side port at 3 or 9 o’clock
3. Capsulorrhexis
   - Fill AC with viscoelastic
   - Perform continuous circular capsulorrhexis with 27 G bent needle
   - Perform hydrodissection (cleavage between cortex and capsule) and hydroleination (cleavage between nucleus and epinucleus)
4. Phacoemulsification of nucleus
   - The aim of phacodynamic control is to remove lens material in a stable chamber, thereby minimizing the risk of complications related to chamber instability
   - Main parameters:
     - Flow/aspiration
     - Vacuum
     - Power
     - Bottle height
   - Peristaltic systems: Flow and vacuum dissociated and can be controlled individually
   - Venturi systems: Only vacuum can be controlled, and serves to determine flow
   - ‘Common’ settings:
     - Sculpting:
       - Continuous power, 30%
     - Low vacuum: 30 mm Hg
     - Low flow: 20–30 cc/min
     - Nucleus disassembly:
       - Burst/pulse/hyperpulse power: 25–30%
       - High vacuum: 250–300 mm Hg
       - High flow: 30–40 cc/min
   - Dealing with chamber instability:
     - Proper wound construction to prevent leaks
     - Lower vacuum and flow/aspiration
     - Raise bottle height
     - Check inflow for kinks/interruptions in tubing or connections
     - Viscoelastic tamponade
     - Start with central sculpting
     - Remove rest of nucleus with various techniques
     - Divide and conquer
     - Chop techniques
5. Soft lens aspiration
   - Aspirate soft lens with automated infusion-aspiration cannula
6. IOL implantation
   - Reform AC with viscoelastics
   - Enlarge main wound to 3 mm (depending on lens insertion technique)
   - Insert foldable IOL into capsular bag
7. Wound closure
   - One 10/0 nylon suture if necessary
   - Subconjunctival steroid/antibiotic injection
This page intentionally left blank
TOPIC 5
ANESTHESIA AND VISCOELASTICS

Opening Question: How do You Administer Regional Anesthesia…? What are the Possible Complications?

“I prefer to use the peribulbar anesthesia technique….”

Retrobulbar and Peribulbar Anesthesia

1. Amount
   - 5 ml of lignocaine 1%
   - Wydase (1 ml diluted into 20 ml of lignocaine) +
   - Adrenaline (2/3 drops of 1:1000)

2. Advantages of peribulbar over retrobulbar anesthesia
   - Lower risk of optic nerve damage
   - Lower risk of systemic neurological effects of anesthesia
   - Lower risk of globe perforation (controversial)
   - No need for facial block

3. Disadvantages of peribulbar over retrobulbar anesthesia
   - Need more anesthetic
   - Less akinesia
   - Longer onset (30 min to attain maximum effect)
   - Higher intraorbital pressure
   - Greater degree of chemosis
   - May need additional superior oblique block (therefore ending up with 2 injections around the globe)

4. Complications and management
   - Retrobulbar hemorrhage
     - Most common complication
     - Proceed with surgery if hemorrhage is small
     - Abort surgery if hemorrhage is large
   - Apply intermittent pressure to compress eye
   - Lateral canthotomy if pressure is too high
   - Globe penetration
   - Abort surgery
   - Fundal examination
   - Usually no need to explore scleral wound (self-sealing)
   - B-scan if vitreous hemorrhage obscures view
   - Refer for retinal consult
     - Cryotherapy or laser photocoagulation for the retinal break
   - Optic nerve damage
     - Direct damage or ischemia
   - Extraocular muscle damage (post-operative motility problems)
   - Neurological effects of anesthetic agents
   - Ptosis (from compression/ocular massage)

5. Alternatives to regional blocks
   - Topical anesthesia
     - Advantages:
       - No complications of injection
       - No increase in orbital volume
       - Avoids periocular bruising
     - Disadvantages:
       - No akinesia
       - Less anesthetic effect (intraocular structures till sensitive; e.g. iris)
   - Sub-Tenon’s injection
   - Intracameral anesthesia
     - 1% preservative-free lignocaine
Exam tips:
• Be precise about the concentration of drugs and amount you give. Say “In my practice, I’ll use 5 ml of 1% lignocaine...” rather than “I’ll use lignocaine...”

How are the Irrigating Solutions Used During Cataract Surgery?

Irrigating Solutions
1. Balance salt solution (BSS)
   • Physiological balanced salt solution
   • Sterile
   • Isotonic
   • Preservative-free
   • Includes: Sodium chloride, potassium chloride, calcium chloride, magnesium chloride, acetate, citrate
   • Epinephrine/antibiotics can be added as well
2. BSS – Plus
   • Enriched with bicarbonate, dextrose, glutathione
   • Less endothelial damage and better lens nutrition (not proven)

Tell me about Viscoelastics.

“Viscoelastics are substances with dual properties of a viscous liquid and elastic solid.”
“They are used extensively in intraocular surgeries.”
“They display various physical properties.”
“The ideal viscoelastic material has the following characteristics....”

Viscoelastics
1. Physical properties
   • Related to chain length and molecular interaction of substances
   • 4 characteristics:
     • Viscoelasticity
       • Refers to tendency to retain original shape and size → shock absorption and endothelial protection
     • Viscosity
   • Refers to resistance to flow → maintain anterior chamber and intraocular volume
   • Pseudoplasticity
     • Refers to ability to transform under pressure from gel to liquid → ease of insertion with increase in pressure
   • Surface tension
     • Refers to coating ability → endothelial protection and surface coating

Exam tips:
• Remember the properties of ideal viscoelastic and compare the advantages and disadvantages of cohesive vs dispersive viscoelastics in terms of these factors.

2. Ideal viscoelastic
   • Optically clear, nontoxic, noninflammatory
   • Chamber maintenance
   • Shock absorption
   • Endothelial protection
   • Surface coating
   • Ease of insertion
   • Ease of removal
   • No IOP rise
### 3. Example

<table>
<thead>
<tr>
<th>Properties</th>
<th>Cohesive</th>
<th>Dispersive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optically clear</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Chamber maintenance</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Shock absorption</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Endothelial protection</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Surface coating</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Ease of insertion</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Ease of removal</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>IOP rise</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

### 4. Indications

- **Cataract surgery** — commonly used during:
  - Anterior capsulotomy
  - Prior to nuclear expression (for ECCE)
  - IOL insertion
  - Other scenarios in which it is used – pupil dilation, free soft lens matter during aspiration of soft lens, tamponade vitreous after PCR
- Penetrating keratoplasty
- Glaucoma surgery
- Corneal laceration
- Retinal detachment surgery (retinal incarceration during SRF drainage)
Intraocular Lens

Opening Question: What are the Types of Intraocular Lens?

“An intraocular lens (IOL) is a clear optical device.”
“Implanted into the eye to replace the crystalline lens.”
“Intraocular lens can be classified as follows…”

Intraocular Lens

1. Rigid posterior chamber intraocular lens (PC IOL)
   - Divided into: Optic and haptic components
   - Either one or three pieces
   - Overall length (12–14 mm)
   - Optic
     - Material (PMMA — Polymethylmethacrylate)
     - Diameter (4.5–7 mm)
     - Design (piano-convex, biconvex, meniscus)
   - Haptic
     - Material (PMMA, prolene — easily deformed, nylon — gradually hydrolyzed)
     - Configuration (closed loop, J or C loop)
     - Angulation of haptic to optic (flat, 10° posterior bowing)
   - Additional features
     - Positioning hole
     - Problem of postoperative diplopia
     - Laser ridges
       - Prevent PCO and decrease damage with Nd:YAG laser capsulotomy
       - Problem of postoperative diplopia
     - Multifocal
       - Central portion for near vision
       - Mechanisms – 3 types
         - Refractive, diffractive and aspherical
         - Problems of postoperative diplopia, haloes, glare and loss of VA
       - Heparin-coated
       - Surface more hydrophilic
       - Decrease inflammation, pigment dispersion and synechiae formation (not proven)

2. Anterior chamber intraocular lens (AC IOL)
   (see below)

3. Foldable PC IOL
   - For small incision cataract surgery
   - Materials:
     - Silicone
     - Acrylic
     - Hydrophobic
     - Hydrophilic
   - Optic color/tints:
     - Clear
     - Yellow (blue-blocker)
     - Violet
   - Convexity (Cornea has positive spherical aberration (SA), normal lens has negative SA)
     - Biconvex std IOL – Positive (SA)
     - Aspheric:
       - Tecnis: Prolate anterior surface = negative SA
       - Acrysof IQ: Negative SA on posterior surface
     - Sorport AO: Pos aspheric — SA free (even power from centre to periphery — not affected by centration/tilt)
   - Edge design:
     - Square
     - Round
     - OptiEdge (Tecnis)
   - Toricity
   - Multifocality
   - Refractive
   - Diffractive
   - Haptic design
     - Material:
       - PMMA (dyed)
       - Prolene – MA60
• Same as optic
• PVDF (Tecnis)
• Shape:
  • Plate
  • Loop
  • Four-point

4. Injectable IOL
5. Scleral-fixated IOL
6. Phakic IOL

Exam tips:
• Remember that you are implanting this foreign object into a patient’s eye. You are therefore expected to know quite a bit about it!

Q Tell me about AC IOL.

“AC IOL is divided into 3 different types. “It is usually indicated for….”

AC IOL
1. Types
• Pupil plane – suture or clip
• Iris supported – suture or clip
• Angle supported – divided into:
  • Rigid angle supported
  • Flexible angle supported – further divided into:
    • Closed loop
    • Open loop “S/Z” shaped or 2/3/4 legs
2. Indications (3 scenarios)
• Secondary IOL implant
• During ECCE/phaco after PC rupture/zonulolysis
  • During planned ICCE
3. Complications with AC IOL
• Endothelial fallout (bullous keratopathy)
• CME (most common cause of poor VA after AC IOL implant)
• Chronic pain and ache (older AC IOL with rigid haptics)
• Glaucoma (uveitis-glaucoma-hyphema (UGH) syndrome)
4. Calculations of AC IOL power (see below)

Clinical approach to anterior chamber IOL

“This patient is pseudophakic with an AC IOL.”
“There is a peripheral surgical iridectomy seen at 2 o’clock.”

Look for
• Bullous keratopathy
• AC activity (uveitis)
• Vitreous in AC/vitreoendothelial touch
• Outline of PCR/shape of pupil (round/peaked)

I’ll like to
• Check IOP
• Check fundus (CME, RD)
Section 1: Cataract and Cataract Surgery

Q What are the Indications and Complications with PC Scleral-Fixated IOL?

1. Indications
   • Similar to AC IOL indications plus
   • Relative \textit{contraindication} to AC IOL implant
     • Younger patient
     • Glaucoma
     • Peripheral anterior synechiae
     • Corneal/endothelial problems
   • Persistent iritis (IOL instability)
   • CME
   • Pupil distortion
   • Hyphema
   • Endophthalmitis
   • Suture erosion over time

2. Complications of PC scleral-fixated IOL
   • IOL tilt/dislocation

Q Under What Situation During Cataract Surgery would You Consider NOT Implanting an IOL?

“In certain scenarios, IOL is not routinely used….”

Patients With
   • Congenital cataract (most common contraindication)
   • Aphakia in fellow eye
   • Recurrent uveitis
   • Posterior segment problems (proliferative DR, RD) and IOL will interfere with treatment of such problems
   • PCR with significant vitreous loss
   • Severe glaucoma
   • Corneal endothelial dystrophy

Q What are the Different IOL Materials?

“What are the different IOL materials?”
“There are many different types of IOL materials....”
“These include....”

IOL Materials

1. Ideal material
   • High optical quality
   • High refractive index (RI)
   • Lightweight
   • Durable
   • Nontoxic/inert (no inflammation, antigenicity, carcinogenicity)
   • Ease of manufacture and sterilization

2. PMMA
   • All the above properties except ease of sterilization (altered by heat, steam, gamma radiation)

3. Glass
   • Potential advantages
     • Good optical quality
     • Autoclavable
   • But
     • Heavy
     • Crack after Nd:YAG capsulotomy

4. Silicone
   • Potential advantages
     • Foldable, inserted into small wound
     • Similar optical quality as PMMA
     • Cast/injection molded (no polishing required)
     • Autoclavable
     • Minimal trauma to tissues
   • But (compared to PMMA)
     • Low RI (thicker)
     • Low tensile strength (tears easily)
     • Slippery (needs dry instruments)
     • Elastic (needs controlled release in anterior chamber)
     • Capsular phimosis
     • Discoloration
     • Contraindicated in patients who need silicon oil later (e.g. DM)

5. Acrylic
   • Potential advantages
     • More control over folding and release of IOL
     • Sticky (less PCO, less capsular phimosis)
     • Less inflammation
     • More resistant to Nd:YAG capsulotomy
   • But (compared to silicone)
     • Less compliant (longer time to compress and results in larger wound)
     • Low tensile strength (tears easily)
     • Higher cost
**How do You Calculate IOL Power?**

“There are 3 types of formulas available....”

**IOL Power Calculation**

1. **Theoretical formulas**
   - Based on optics/vergence equations
   - E.g. Holliday, Binkhorst

2. **Empirical formulas**
   - Based on regression analysis on refraction results from patients with cataract surgery and IOL
   - E.g. SRK (Sander-Retzlaif-Kraff)

3. **Combination formulas**
   - Theoretical formula with regression analysis added to optimize the equations
   - E.g. SRK-T

4. **Choice of formula**
   - Main factor is axial length of eye
   - Royal College of Ophthalmologists’ recommendations:
     - AL < 22.0 mm – Hoffer/SRK-T
     - AL 22.0–24.5 mm – SRK-T/Holladay, Haigis
     - AL > 24.6 mm: SRK-T

**Tell me about the SRK Formula.**

“The SRK is an IOL power calculation formula and stands for....”

**SRK Formula**

1. **Power** = (A constant) – 2.5 (axial length) – 0.9 (keratometry)

2. **Factors which affect the A constant**
   - Position of IOL in eye (closer the IOL to retina, higher the A constant, therefore AC IOL has lower A constant!)
   - Shape of IOL (convex, biconvex etc)
   - Haptic angulation

3. **Choosing power of AC IOL when PCR occurs**
   - Suppose a 20D PC IOL was chosen with an A constant of 118
   - The AC IOL has a constant of 114
   - Then the desired power of AC IOL is
     \[ 20D - (118 - 114) = 16D \]

**How do You Choose the Final IOL Power?**

“Selection is based on the patient’s refractive status in the eye due for cataract surgery, the patient’s visual requirements and the state of the fellow eye.”

**IOL Power Selection**

1. **Emmetropic eye (−0.5 to +0.5D)**
   - Active patient → aim for emmetropia
   - Sedentary, elderly → aim for slight myopia

2. **Slight hyperopia (+0.5 to 3.0D)**
   - Aim for emmetropia

3. **High hyperopia (> +3.0D)**
   - Fellow eye needs cataract operation → aim for emmetropia
   - Fellow eye does not need operation → aim for slight hyperopia

4. **Slight myopia (−1.0 to 3.0D)**
   - Active patient → aim for emmetropia
   - Sedentary, elderly → aim for slight myopia of −2.0 to 2.5D

5. **High myopes**
   - Many surgical issues involved must be explained (see page 27)
   - Fellow eye needs cataract operation → aim for slight myopia (then aim for emmetropia in fellow eye)
   - Fellow eye is as myopic but does not need cataract operation → aim for myopia with 2–3D difference compared with fellow eye (or aim for emmetropia and use contact lens for fellow eye)
   - Fellow eye is emmetropic → consider the possibility that operated eye may have amblyopia!
What are the Principles of Ultrasound Biometry?

Ultrasound Biometry

1. Principles
   - Ultrasound = acoustic (sound) waves at frequency > 20 kHz (20,000 cycles/sec)
   - Produced from an electric pulse in piezoelectric crystal (keyword)
   - Echoes
     - A-scan (time–amplitude)
     - B-scan (brightness modulated)
   - Frequency
     - Increase in frequency is associated with a decrease in penetration, but an increase in resolution
     - Ophthalmic use (8–12 MHz) vs obstetric use (1 MHz)
   - Sound velocity
     - Faster through denser medium
   - Velocities
     - Cornea/lens (1,641 m/sec)
     - Aqueous/vitreous (1,532 m/sec)
     - PMMA (2,718 m/sec)
     - Silicone (980 m/sec)
   - Acoustic impedance
     - Impedance = density × sound velocity
   - Acoustic interface
     - Formed when sound travels between media of differing acoustic impedances

2. Measurements
   - A-scan ultrasound determines time required for sound to travel from cornea to retina and then back to probe
     - (Distance = velocity × time/2)
   - Gain
     - Increase in gain is associated with an increase in tissue penetration and sensitivity but decrease in resolution
   - Accuracy of axial length
     - 0.1 mm = error of 0.25D in an emmetropic eye, more in a short eye and less in a longer eye (see SRK formula)
   - Standard dimensions
     - Multiple measurements between two eyes should be within 0.2 mm and difference in length between two eyes should be within 0.3 mm
   - Mean values
     - Axial length = 23.5 mm
     - Corneal thickness = 0.55 mm
     - AC depth = 3.24 mm
     - Lens thickness = 4.63 mm

3. Measurement errors and other issues
   - Artificially too short
     - Corneal compression
     - Sound velocity too slow, improper gate settings or gain too high
     - Misalignment of sound beam
   - Artificially too long
     - Fluid between cornea and probe
     - Sound velocity too fast, improper gate settings or gain too low
     - Misalignment of beam
     - Staphyloma
     - Silicone oil
     - Pseudophakia
     - PMMA IOL – eye measure shorter
     - Silicone IOL – eye measure longer
     - Conversion factors (measure using aphakic sound velocity and add the above factors)
       - PMMA (+0.4)
       - Silicone (~0.8)
       - Acrylic (+0.2)

What is Partial Coherence Biometry?

“Partial coherence biometry (e.g. IOL Master) is a new biometric tool that utilizes infrared light (wavelength 780 nm) instead of sound waves for biometric measurements.”

Advantages Over Ultrasound Biometry:
   - Non-contact
   - Faster (<1 sec)
   - Easier to perform
   - Measures along fixation beam: More accurate for high myopia (almost mandatory in presence of staphyloma!)
   - No correction needed for silicone oil filled eyes
**What is the Role of Ultrasound in Ophthalmology?**

“Ultrasound is used for diagnosis and treatment.”

**Diagnostic**

1. Anterior segment
   - Pachymetry
   - Biometry
   - Biomicroscopy (AC angles)
   - Lens thickness
2. Post segment
   - Vitreous opacity (vitreous hemorrhage, posterior vitreous detachment)
   - Retina (RD, tumors)
   - Choroid (choroidal detachment, tumors)
   - IOFB
3. Orbit
   - Tumor, cyst, mucocoele, FB (superceded by CT scan)
4. Doppler
   - Carotid duplex
   - Blood flow to optic nerve head
   - Orbital color doppler imaging
   - Ophthalmic artery duplex

**Post-Keratorefractive Surgery Biometry**

1. Main challenges in post-refractive surgery biometry
   - Keratometers only measure K in central zone which may not encompass entire treatment/ablation zone
   - Standard Keratometry index (1.3375) assumes constant relationship between anterior and posterior corneal surfaces – not true after corneal ablation
2. Approaches to biometry:
   - Methods which do not rely on current data (historical data methods)
     - Based on records of pre-refractive surgery K values, with adjustment based on amount of refractive correction
     - Various formulae
   - Methods based on current data
     - Contact lens overrefraction: Effective K = contact lens base curve – difference between refraction with and without contact lens
     - Pentacam based formulae (direct measurement of posterior corneal curvature)
**Q** Opening Question: How do You Manage this Patient with Glaucoma and Cataract?

“In this patient, there are 2 clinical problems that have to be managed simultaneously.”
“This would depend on the severity of each condition…”
“Factors to consider would include….”

Management of Glaucoma and Cataract

<table>
<thead>
<tr>
<th>Severity of glaucoma</th>
<th>Severity of cataract</th>
<th>Possible options</th>
</tr>
</thead>
<tbody>
<tr>
<td>+++</td>
<td>+</td>
<td>Trabeculectomy first, cataract operation later</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alternatively, discuss with patient about advantages of combined cataract operation and trabeculectomy (triple procedure) (see below)</td>
</tr>
<tr>
<td>+</td>
<td>+++</td>
<td>Cataract operation first, manage glaucoma conservatively</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alternatively, discuss with patient about advantages of triple procedure (see below)</td>
</tr>
<tr>
<td>+++</td>
<td>+++</td>
<td>Consider triple procedure</td>
</tr>
</tbody>
</table>

Factors that Determine the Management of Glaucoma and Cataract

1. **Severity and progression of glaucoma**
   - IOP level (most important factor)
   - Optic nerve head changes
   - Visual field changes
   - Ocular risk factors (CRVO, Fuch’s endothelial dystrophy, retinitis pigmentosa)

2. **Severity and progression of cataract**
   - VA and visual requirements

3. **Patient factors**
   - Age
   - Race (blacks higher rate of glaucoma progression)
   - Family history of blindness from glaucoma
   - Fellow eye blinded from glaucoma
   - Concomitant risk factors for glaucoma (DM, HPT, myopia, other vascular diseases)
   - Compliance to follow-up and medication use
Exam tips:
- Remember there are no RIGHT or WRONG answers. You must be able to come up with a position and defend it.
- Be as conservative as possible. Therefore give extremes of each scenario first (least controversial), then go on to the more difficult and controversial areas.
- Opening statement is similar in all situations in which there are 2 problems, “There are 2 clinical problems that must be managed simultaneously. Factors to consider in these patients include…”
- See factors that determine glaucoma management (page 63).

Q What are the Indications for a Combined Cataract Extraction and Trabeculectomy?

“In general, this procedure is indicated when there is SIMULTANEOUS need for trabeculectomy and cataract operation.”

Combined Cataract Extraction and Trabeculectomy

1. Indications
   - General principle: Indications for trabeculectomy (when IOP is raised to a level that there is evidence of progressive VF or ON changes despite maximal medical treatment) plus indication for cataract surgery (visual impairment)

2. Advantages
   - One operation
   - Faster visual rehabilitation
   - Patient may be able to be taken off all glaucoma medications
   - Prevents post-op IOP spikes
   - HVF monitoring easier with clear media
   - No subsequent cataract operation needed (lower risk of bleb failure)

3. Disadvantages
   - Strong evidence that IOP control with trabeculectomy alone is better than combined surgery
   - More manipulation during the combined operation (higher risk of bleb failure)
   - Vitreous loss during cataract surgery (higher risk of bleb failure)
   - Larger wounds created (higher risk of wound leakage and shallow AC)

4. Alternative ways to perform the combined operation
   - Corneal section ECCE plus trabeculectomy
     - Advantages
       - More control
       - Less conjunctival manipulation
       - Smaller wound (lower risk of leakage and shallow AC)
     - Disadvantages
       - Longer
       - Higher corneal astigmatism
   - Limbal section ECCE plus trabeculectomy
     - Advantages
       - Faster
       - Less astigmatism
     - Disadvantages
       - Larger wound
       - More conjunctival manipulation
       - Increased risk of flat AC
   - Phacoemulsification plus trabeculectomy
     - Advantages
       - More control of AC
       - Less conjunctival manipulation (main reason)
       - Smallest wound of the 3 techniques
       - Less astigmatism
       - Faster
     - Disadvantage:
       - More difficult operation for the inexperienced surgeon

Exam tips:
- Essentially identical to the indications for trabeculectomy (page 80).
Section 1: Cataract and Cataract Surgery

2. Intraoperative stage
   - Risk of perforation with retrobulbar anesthesia (consider topical anesthesia or GA)
   - Lower IOP (harder to express nucleus during ECCE)
   - Deeper AC (harder to aspirate soft lens material)
   - Increased risk of PCR (weak zonules)

3. Postoperative stage
   - Risk of RD

Notes
- “What are the common scenarios for trabeculectomy?”
- Uncontrolled POAG with maximal medical treatment
  - Failure of medical treatment (IOP not controlled with progressive VF or ON damage)
  - Side effects of medical treatment
  - Noncompliance with medical treatment
  - Additional considerations
    - Young patient with good quality of vision
    - One-eyed patient (other eye blind from glaucoma)
    - Family history of blindness from glaucoma
    - Glaucoma risk factors (HPT, DM)
- Uncontrolled PACG after laser PI and medical treatment
- Secondary OAG or ACG

Q What are the Potential Problems in Removing a Cataract in a Patient with High Myopia?

“There are several potential problems, which can be divided into....”

High Myopia and Cataract Surgery

1. Preoperative stage
   - Need to assess visual potential (amblyopia, myopic macular degeneration)
   - Choose IOL power carefully (counseling for anisometropia)
   - Harder to do biometry (need special formulas to adjust for longer axial lengths)
   - IOL Master biometry in view of high prevalence of staphylomata

2. Intraoperative stage
   - Problem of small pupil (see below)
   - Increased risk of PCR (weak zonules)

3. Postoperative stage
   - Higher risk of complications
     - Corneal edema
     - Flare up of inflammation
     - Glaucoma or hypotony
     - Choroidal effusion
     - CME
   - Consider prophylaxis for infectious etiologies (e.g. herpetic lesions)

Q What are the Potential Problems in Removing a Cataract in a Patient with Uveitis?

Uveitis and Cataract Surgery

1. Preoperative stage
   - Need to control inflammation
     - Consider waiting 2 to 3 months until inflammation settles after an acute episode
     - Consider course of preoperative steroids
   - Assess visual potential (CME, optic disc edema)
   - Dilate pupil in advance (atropine, subconjunctival mydriacaine)
   - Perform gonioscopy (if synechiae is severe superiorly, consider corneal section)

2. Intraoperative stage
   - Problem of small pupil (see below)
   - Increased risk of PCR (weak zonules)

3. Postoperative stage
   - Higher risk of complications
     - Corneal edema
     - Flare up of inflammation
     - Glaucoma or hypotony
     - Choroidal effusion
     - CME
   - Consider prophylaxis for infectious etiologies (e.g. herpetic lesions)
**How do You Manage a Small Pupil During Cataract Surgery?**

**Small Pupil During Cataract Surgery**

1. **Preoperative stage**
   - High risk patients (uveitis, DM, pseudoexfoliation syndrome, Marfan’s syndrome, glaucoma on pilocarpine treatment)
   - Prior to operation, prescribe mydriatics (3 days of homatropine 2% three times a day or atropine)
   - 2 hours before operation, intensive dilation with Tropicamide 1%
   - Ocufen 0.03%
   - Phenylephrine 10%

2. **Intraoperative stage**
   - Infuse AC with balanced salt solution mixed with a few drops of 1:1000 Adrenaline

---

**Exam tips:**
- Common follow-up question of pseudoexfoliation (page 18) and uveitis (see above).
- Give practical answers. Do not say “iris hooks” first or you will be asked in detail how to do it!

**What are the Problems Operating on a Mature Cataract?**

**Mature Cataract**

1. Need to assess visual potential
   - Pupils (optic nerve function)
   - Light projection (gross retinal integrity, color perception)
   - Potential acuity meter (macular function)
   - B-scan ultrasound (gross retinal anatomy)

2. Poor view of capsulotomy/capsulorrhexis edge
   - Consider endocapsular technique

---

**What are the Issues in Cataract Extraction for Diabetic Patients?**

**Diabetes and Cataract**

1. Issues
   - Difficult cataract surgery
   - Progression of diabetic retinopathy after operation

2. Preoperative stage
   - Assess visual potential
   - Consider FFA

---

**Q** What are the Issues in Cataract Extraction for Diabetic Patients?

“The 2 main issues are….”

- Laser PRP if necessary prior to the surgery
- Medical consult
- List for first case in morning

---

32 The Ophthalmology Examinations Review
• Problems with small pupil (see above)
• Consider stitching wound
• Selection of IOL
  • Large optics (7 mm)
  • Use acrylic IOL (avoid silicone IOL)
  • Avoid IOL if PDR (risk of neovascular glaucoma)
• Avoid AC IOL
• Consider heparin-coated IOL

4. Postoperative stage
• Control inflammation (especially in eyes with PDR)
• Risk of PDR/CSME
• Risk of glaucoma
• Risk of PCO

Notes
• “Why does diabetic retinopathy progress?”
• Removal of anti-angiogenic factor in lens
• Secretion of angiogenic factors from iris
• Increased intraocular inflammation
• Decreased anti-angiogenic factor from RPE
• Migration of angiogenic factors into AC
Q Opening Question: What are the Issues in Cataract Extraction for Diabetic Patients?

“The complications can be classified into 3 categories: Preoperative, intraoperative and postoperative complications.”

Complications of Cataract Surgery

1. Intraoperative
   - Posterior capsule rupture (PCR) and vitreous loss
   - Suprachoroidal hemorrhage
   - Dropped nucleus

2. Early postoperative
   - Endophthalmitis
   - Wound leak
   - IOP related problems (raised IOP, low IOP and shallow AC)
   - Corneal edema (striate keratopathy)

3. Late postoperative
   - Late endophthalmitis
   - Wound astigmatism
   - Glaucoma
   - Bullous keratopathy
   - Posterior capsule opacification
   - Retinal detachment

Exam tips:
- Complications of all eye operations are extremely important, because you are expected to manage them.
- There are a few ways to answer these questions, choose one and be comfortable with it.
- The most common complication answer, “The commonest ocular complication is…”
- The most important complication answer, “The most important complication is endophthalmitis…”
- The clinical classification answer, “The complications can be classified into preoperative, intraoperative and postoperative complications….”
- The anatomical classification answer, “The complications can be divided into anterior or posterior segment….”

Exam tips:
- Notice an intentional grouping of early postoperative and late postoperative complications into similar groups (i.e. endophthalmitis, wound problems, IOP problems, corneal problems, PC problems and retinal problems)!
How do You Manage a Posterior Capsule Rupture (PCR) During Cataract Surgery?

“The management depends on the stage of the operation, the size and extent of PCR and whether vitreous loss has occurred.”

“The risk factors include….”

Management of PCR

1. Management depends on
   - Stage of operation at which PCR occurs, commonly during:
     - Nucleus expression
     - Aspiration of soft lens
     - IOL insertion
   - Size and extent of PCR
   - Presence or absence of vitreous loss

2. Risk factors
   - Ocular factors
     - Difficult cataracts (brunescent, morgagnian, pseudoxfoliation, posterior polar cataracts)
     - Glaucoma
     - High myopia
     - Increase in vitreous pressure observed after retrobulbar and peribulbar anesthesia
     - Small pupils
     - Small CCC
   - Patient factors
     - HPT
     - Chronic lung disease
     - Obese patient with short thick neck

3. Clinical signs of PCR
   - Presence of ring reflex in the posterior capsule
   - Inability to aspirate soft lens matter (vitreous stuck to port)
   - Outline of PCR seen
   - Peaked pupil
   - Vitreous seen in AC
   - Sudden deepening of AC
   - Fragments disappear from view
   - Pupil-snap sign: PC rupture during hydrodissection

4. General principles of management
   - Intraoperative stage
     - Stop surgery immediately and assess situation
     - Limit size of PCR (inject viscoelastic into AC)
   - Dealing with remaining lens matter
     - Small fragment
     - Enlarge wound and express with Vectis
   - Phaco over Sheets glide (reduce parameters)
   - Large fragment – convert to ECCE/posterior assisted techniques
   - Remove remaining soft lens matter with gentle and “dry” aspiration
   - Vitreous loss
     - Anterior vitrectomy (sponge vitrectomy or automated vitrectomy) settings
     - Consider IOL implantation
     - PC IOL (small PCR) – convert rupture to round posterior CCC
     - Sulcus IOL (moderate to large PCR with adequate PC support)
     - Avoid one-piece lenses: Chafing and instability
     - IOL power has to be adjusted (reduced) to account for more anterior position
     - AC IOL (large PCR with inadequate posterior capsule support)
     - Leave aphakic (large PCR with inadequate posterior capsule support)
     - Avoid silicone lenses in PCR – higher rate of endophthalmitis
     - Consider IOL capture in CCC for stability
   - Checklist at the end of operation
     - Obvious vitreous at pupil borders?
     - Inject miotic agent → round pupil observed?
     - Traction at wound edge with weck sponge → peaking of pupil?
       (Marionette sign)
     - Inject air bubble → regular round bubble observed?
     - Sweep iris → movement in AC
   - Postoperative – risk of
     - Endophthalmitis
     - Glaucoma
     - Inflammation
     - Bullous keratopathy
     - Suprachoroidal hemorrhage
     - CME
     - RD

How do You Manage a Suprachoroidal Hemorrhage?

“Suprachoroidal hemorrhage is a rare but blinding complication of cataract extraction.”
Suprachoroidal Hemorrhage

1. Risk factors
   • Ocular factors
     • Glaucoma
     • Severe myopia
     • PCR during surgery
   • Patient factors
     • HPT
     • Chronic lung disease
     • Obese patient with short thick neck

2. Clinical signs
   • Progressive shallowing of AC
   • Increased IOP
   • Prolapse of iris
   • Vitreous extrusion
   • Loss of red reflex

   • Dark mass behind pupil seen
   • Extrusion of all intraocular contents

3. General principles of management
   • Intraoperative
     • Stop surgery
     • Immediate closure with 4/0 silk suture (use superior rectus stitch)
     • IV mannitol
     • Posterior sclerostomy
       • Controversial and may exacerbate bleeding
   • Postoperative
     • Risk of glaucoma (need timolol) and inflammation (need pred forte)
     • May need to drain blood later on (vitrectomy)

Exam tips:
• The risk factors are nearly identical to that for PCR!

Q How do You Manage a Dropped Nucleus During Phacoemulsification?

“The management of a dropped nucleus depends on the stage of the operation, the amount of the lens fragment dropping into the vitreous and whether vitreoretinal surgical help is available.”

Dropped Nucleus

1. Why in phacoemulsification, but not in ECCE?
   • PCR more difficult to see in phacoemulsification
   • High pressure AC system (infusion solutions)

2. Types of dropped nucleus
   • Prior to nucleus removal
     • Whole nucleus drop
     • Runaway capsulorrhesis or during hydrodissection
   • During nucleus removal
     • Nuclear fragment drop
     • Phacoemulsification of posterior capsule, puncture or aspirate capsule
   • After nucleus removal
     • PCR is associated with vitreous loss but no nuclear drop
     • Management similar to PCR in ECCE

3. General principle of prevention
   • Good sized and shaped capsulorrhesis
   • Careful hydrodissection
   • Clear endpoints in nuclear management
   • Recognition of occult PCR

4. Management
   • Stabilize AC with viscoelastics and remove phacoprobe. Enlarge wound
   • Inject viscoelastics under nucleus if possible
   • Retrieve fragments with vectis/forceps/posterior assisted techniques
     • Controversial: May increase vitreous traction and risk of retinal breaks
   • Either close wound and remove fragments at later date, or proceed with immediate vitrectomy and nucleus removal

Notes
• “What are the signs of an impending nuclear drop?”
  • Runaway capsulorrhesis
  • “Pupil snap” sign (pupil suddenly constricts)
  • Difficulty in rotation of nucleus
  • Nuclear tilt
  • Receding nucleus
Tell me about Postoperative Endophthalmitis.

“Postoperative endophthalmitis is a rare but blinding complication after cataract surgery.”
“The management depends on isolation of organism, intensive medical treatment and surgical intervention if necessary.”

### Classification and Microbial Spectrum

<table>
<thead>
<tr>
<th>Classification</th>
<th>Types</th>
<th>Incidence</th>
<th>Microbial spectrum</th>
<th>Onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endogenous</td>
<td>• Generalized septicemia</td>
<td></td>
<td>• Klebsiella and gram negatives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Localized infections</td>
<td></td>
<td>• Depending on source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(endocarditis, pyelonephritis, osteomyelitis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exogenous</td>
<td>• Postoperative (cataract)</td>
<td>0.1%</td>
<td>• S. epidermidis (70%)</td>
<td>1–14 days</td>
</tr>
<tr>
<td></td>
<td>• Postoperative (glaucoma)</td>
<td>1%</td>
<td>• S. aureus, Streptococcus</td>
<td>Early to late</td>
</tr>
<tr>
<td></td>
<td>• Post traumatic</td>
<td>5–10%</td>
<td>• Propionibacterium species (chronic)</td>
<td>1–5 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Streptococcus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Hemophilus influenza</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• S. epidermidis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• S. aureus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Propionibacterium species (chronic)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Bacillus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gram negatives</td>
<td></td>
</tr>
</tbody>
</table>

### Postoperative Endophthalmitis

1. **Clinical features**
   - Pain
   - Decreased VA
   - Lid edema and chemosis
   - Corneal haze
   - AC activity, hypopyon, fibrin
   - Absent red reflex
   - Vitritis

2. **General principles of management**
   - Prevention
     - Preoperatively: Only irrigation of conjunctival sac with 5% povidone iodine has been shown to reduce endophthalmitis risk
     - Other measures like antibiotics not proven but commonly employed
     - Intraoperatively:
       - ESCR multi-center study on intra-cameral antibiotic prophylaxis showed that use of intra-cameral cefuroxime (1 mg/0.1 ml) was associated with 5x reduced risk of endophthalmitis
   - Medical treatment
     - Intravitreal antibiotics
     - Intensive fortified topical antibiotics
     - Systemic antibiotics (controversial)
     - Steroids (controversial – usually better given systemically)
   - Surgical treatment
     - Vitrectomy
       - Endophthalmitis vitrectomy study
         (Arch Ophthalmol 1995; 113:1479)
         - 420 patients with post cataract surgery endophthalmitis
         - Randomly assigned to either early vitrectomy vs vitreous tap and IV antibiotics vs topical and intravitreal antibiotics.
         - Results: Immediate vitrectomy only beneficial in patients with perception of light vision or worse. No benefit of IV antibiotics
   - **Vitreous tap to isolate organism (see below)**
Exam tips:
- Be careful, “postoperative endophthalmitis” is not the same as “endophthalmitis” (the latter includes endogenous and post-traumatic endophthalmitis).
- The incidence after cataract surgery is 1 in 1,000 (0.1%) but is 10 times higher in glaucoma surgery (1%) and 100 times higher after trauma (5–10%).

Q How do You Perform a Vitreous Tap?

“I would perform a vitreous tap in the operating room under sterile conditions.”
“First I would prepare the antibiotics and culture….”

Vitreous Tap
1. Perform in OR under sterile conditions
2. Prepare antibiotics and culture media before procedure
   - 0.2 ml of antibiotic
     • Cephazolin 2.5 mg in 0.1 ml
     • Vancomycin 1 mg in 0.1 ml
     • (Alternatives: Amikacin 0.4 mg in 0.1 ml, ceftazidime 2.25 mg in 0.1 ml)
   • Topical LA, clean eye with iodine
3. Procedure
   • Use 23G needle mounted on Mantoux syringe with artery forceps clamped 10 mm from tip of needle
   • Enter pars plana from temporal side of the globe, 4 mm behind limbus, directed towards center of vitreous
   • If no fluid aspirated, reposition or consider use of hand-held automated vitrector
   • Withdraw 0.2 ml of vitreous, remove syringe and inject pus/contents onto culture media
   • Inject 0.2 ml of antibiotics

Q Tell me about Posterior Capsule Opacification (PCO) after Cataract Surgery.

“There is 3 types of PCO….”

Management of PCO
1. Types of PCO
   • Proliferation of epithelium (Elschnig’s pearls and Soemmering’s ring)
   • Primary opacification of capsule
   • Primary fibrosis of capsule
2. Problems with PCO
   • Visual dysfunction (VA, contrast, color)
   • Decrease view of fundus – management of diabetic retinopathy
   • RD
   • IOL decentration with capsular phimosis
3. Risk factors for PCO
   • Young patient
   • DM, uveitis
   • Retained lens matter during surgery
   • IOL design (controversial) – square edged designs reduce PCO risk
4. General principles of management
   • Intraoperative stage – prevention of PCO
     • Surgical factors
       • Complete removal of soft lens matter
       • Polish posterior capsule
       • Consider primary posterior capsulotomy (pediatric cataract)
     • IOL design factors
       • Acrylic IOL (lower risk because more IOL/posterior capsule apposition)
       • Posterior bowing of optic (more IOL/posterior capsule apposition)
       • Laser barrier ridges (prevent epithelium from migrating behind IOL)
       • Heparin-coated IOL (not proven)
5. Postoperative treatment
   • Nd:YAG capsulotomy [timing]
Q What are the Causes of Raised IOP/Low IOP/Shallow AC after Cataract Surgery?

“Management depends on the severity and cause of the shallow AC….”
“The severity is graded as follows (see page 82).”
“The possible causes of shallow anterior chamber are….”

<table>
<thead>
<tr>
<th>IOP</th>
<th>Shallow AC</th>
<th>Deep AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>• Malignant glaucoma</td>
<td>• Retained viscoelastics</td>
</tr>
<tr>
<td></td>
<td>• Suprachoroidal hemorrhage</td>
<td>• Retained soft lens matter</td>
</tr>
<tr>
<td></td>
<td>• Pupil block glaucoma</td>
<td>• Inflammation, hyphema</td>
</tr>
<tr>
<td>Low</td>
<td>• Wound leak</td>
<td>• Ciliary body shutdown</td>
</tr>
<tr>
<td></td>
<td>• Choroidal effusion</td>
<td>• Retinal detachment</td>
</tr>
</tbody>
</table>

Exam tips:
- Very similar causes to shallow AC after trabeculectomy (see page 82).

Q How do You Control Postoperative Corneal Astigmatism?

Corneal Astigmatism after Cataract Surgery

1. Preoperative stage
   • Assess amount of astigmatism
   • Use keratometry readings (not manifest refraction because astigmatism may be due to lenticular astigmatism)
   • Consider astigmatism of the other eye (with- or against-the-rule astigmatism)
   • Plan surgery (ECCE vs phacoemulsification)

2. Intraoperative — prevention
   - ECCE
     • Decrease size of incision
     • Less diathermy
     • Place IOL centrally
     • Wound closure/suture techniques
       • Regularly placed sutures, short, deep bits
       • If there is overlapping of wound edges, sutures are too tight (with-the-rule astigmatism)
   - Phacoemulsification
     • Site of incision
       • Temporary or superior incision (based on preoperative astigmatism)
       • Cornea, limbal or scleral tunnel (less astigmatism with scleral tunnel)
   - Avoid wound burns
   - Limbal relaxing incisions
   - Corneal relaxing incisions (less predictable)
     • Newer technique: Femtosecond assisted keratotomy for greater predictability
   - Toric IOLs: Currently correct up to 3D astigmatism
     • Prerequisites:
       • Astigmatically neutral/predictable incision
       • Stable in the bag IOL fixation

3. Postoperative management
   • Manipulate frequency of steroid drops
   • With-the-rule astigmatism → more steroids (delay healing, wound will slide)
   • Against-the-rule → less steroids (increase healing and fibrosis)
   • Selective suture removal according to astigmatism
   • Toric contact lens
   • Photorefractive keratectomy/excimer laser procedures
   • Accurate keratotomy
TOPIC 9

SUBLUXED LENS AND MARFAN’S SYNDROME

Opening Question: What are the Causes of Subluxed or Dislocated Lens?

“Subluxed lens can be classified into 2 groups: Primary or secondary.”

Classification of Subluxed Lens

1. Primary
   - Idiopathic
   - Familial ectopic lentis (usually AD)

2. Secondary
   - Systemic disorders
     - Marfan’s syndrome
   - Other connective tissue disorders (Weil Marchesani, Stickler’s, Ehler Danlo’s syndromes)
   - Metabolic disorders (homocystinuria, hyperlysinemia)
   - Ocular developmental disorders
     - Big eyes and cornea (megalocornea, high myopia, bulphthalmos)
   - Iris anomalies (aniridia, uveal coloboma, corectopia)
   - Ocular diseases/acquired
     - Trauma
     - Uveitis
     - Hypermature cataracts, pseudoexfoliation syndrome
     - Anterior uveal tumors (ciliary body melanoma)

Exam tips:
- The classification is identical for congenital glaucoma (page 57) and congenital cataract (page 9!)

What are the Symptoms and Signs of Subluxed or Dislocated Lens?

Clinical Features

1. Symptoms
   - Fluctuating vision
   - Difficulty in accommodation
   - Monocular diplopia
   - High monocular astigmatism
   - Iridodonesis (better seen with undilated pupil)
   - Deep or uneven AC
   - Uneven shadowing of iris on lens
   - Superior or inferior border of lens and zonules seen
   - Acute ACG

2. Signs
   - Phacodonesis
How would You Manage a Patient with Subluxed Lens?

“I would need to assess the cause of the subluxation and manage both the ocular and systemic problems.”
“If the lens is dislocated into the AC….”

Management of Subluxed Lens

1. Dislocation
   • Into AC
     • **Ocular emergency**, immediate surgical removal
   • Into vitreous
     • Lens capsule intact and no inflammation, consider leaving it alone
     • Lens capsule ruptured with inflammation, surgical removal indicated (pars plana lensectomy)

2. Subluxed lens
   • If asymptomatic, conservative treatment (spectacles or contact lens)
   • Surgical removal indicated if there is
     • Lens-induced glaucoma
     • Persistent uveitis
     • Corneal decompensation
     • Cataract
   • Severe optical distortion (despite conservative treatment)
   • Surgical techniques
     • Standard ECCE/phaco (minimal subluxation, intact zonules)
     • ICCE (moderate subluxation, weaken zonules)
     • ICCE with anterior vitrectomy (associated with vitreous loss)
   • Phaco with devices for capsular stabilization
     • Surgical pearls:
       • Intact CCC is critical to successful implantation of capsular stabilization devices
       • CCC initiation may be difficult — use sharp needle
       • Start CCC small, use shear method to control size
       • Aim is to implant CTR as late as possible during surgery, ideally after nucleus removed (CTR is bulky and difficult to implant smoothly when lens still present)
       • Temporary capsular stabilization during surgery can be achieved with capsular tension segments and iris/capsular hooks
       • Lower phaco parameters
       • Use chop techniques to minimize zonular stress
       • <1 quadrant zonulysis: Capsular tension ring (CTR)
       • 1–2 quadrants zonulysis: Cionni 1L modified CTR
       • >2 quadrants zonulysis: Cionno 2L modified CTR

What are the Clinical Features of Marfan’s Syndrome?

“Marfan’s syndrome is a systemic connective tissue disorder.”
“There are characteristic systemic and ocular features.”

Marfan’s Syndrome

1. Systemic features
   • AD inheritance
   • Skeletal
     • Tall and long arms (inappropriately long armspan to height)
     • Fingers (arachnodactyly, joint laxity)
     • High arched palate
     • Scoliosis and pectus abnormalities
     • Hernias
   • Cardiac
     • Mitral valve prolapse
     • Aortic aneurysm, aortic incompetence and aortic dissection

2. Ocular features
   • Anterior segment
     • Subluxed lens (bilateral, upward, symmetrical)
     • Glaucoma (angle anomaly)
     • Keratoconus
     • Hypoplasia of dilator pupillae (difficult to dilate pupils)
   • Posterior segment
     • Axial myopia
     • RD
Clinical approach to Marfan’s syndrome

“On SLE, there is bilateral upward dislocation of lens.”
“However, the lens is not cataractous and the zonules can be seen inferiorly.”

Look for

• Corneal evidence of keratoconus
• Dilated pupil
• Systemic features
  • High arched palates
  • Arachnodactyly, joint flexibility
  • Tall, wide armspan, scoliosis, chest deformity

I’d like to

• Check the IOP
• Perform a gonioscopy
• Refract the patient (high myopia)
• Examine the fundus (myopic changes and RD)
• Examine the cardiovascular system (aortic incompetence, mitral valve prolapse)
• Evaluate family members (for Marfan’s syndrome)

Exam tips:

• Listen to the question, “What are the CLINICAL FEATURES?” which is different from “What are the OCULAR features?”

What are the Differences between Marfan’s Syndrome, Homocystinuria and Weil Marchesani Syndrome?

<table>
<thead>
<tr>
<th></th>
<th>Marfan’s</th>
<th>Homocystinuria</th>
<th>Weil Marchesani</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inheritance</td>
<td>AD</td>
<td>AR</td>
<td>AD</td>
</tr>
<tr>
<td>Intellect</td>
<td>Normal</td>
<td>Mental retardation</td>
<td>Mental retardation</td>
</tr>
<tr>
<td>Fingers</td>
<td>Arachnodactyly</td>
<td>—</td>
<td>Short stubby fingers</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>—</td>
<td>Severe</td>
<td>—</td>
</tr>
<tr>
<td>Vascular complications</td>
<td>—</td>
<td>Severe</td>
<td>—</td>
</tr>
<tr>
<td>Cardiac</td>
<td>Severe</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lens subluxation</td>
<td>Upwards</td>
<td>Downwards</td>
<td>Downwards</td>
</tr>
<tr>
<td></td>
<td>Zonules present</td>
<td>Zonules absent</td>
<td>Microspherophakia</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Intact</td>
<td>Lost</td>
<td>—</td>
</tr>
</tbody>
</table>