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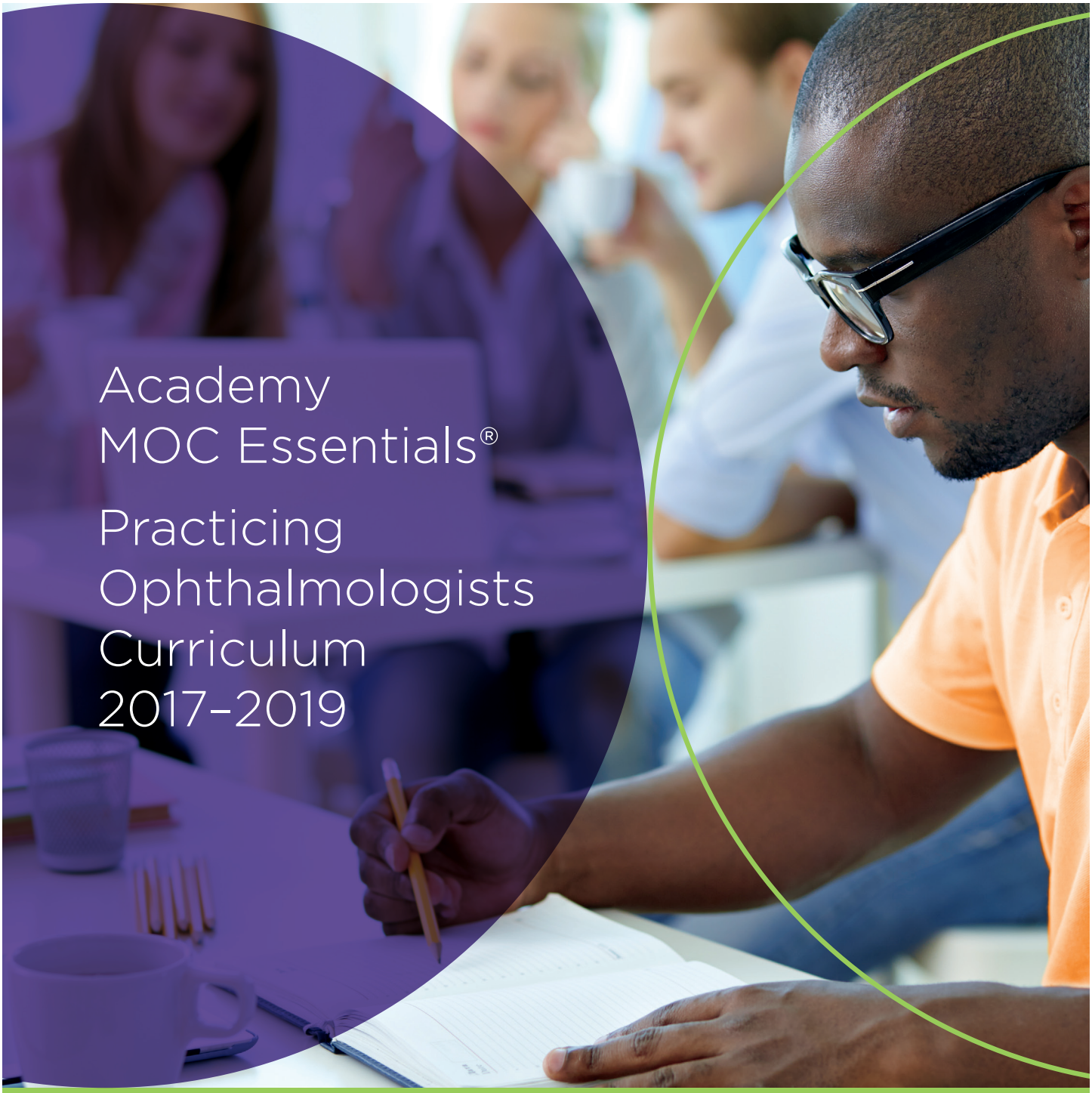

Academy MOC Essentials®

Practicing Ophthalmologists Curriculum 2017–2019

Cataract/Anterior Segment

Protecting Sight. Empowering Lives.™

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Practicing Ophthalmologists Curriculum
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Practicing Ophthalmologists Curriculum
Authors and Financial Disclosures

The Practicing Ophthalmologists Curriculum was developed by a group of dedicated ophthalmologists reflecting a diversity of background, training, practice type and geographic distribution.

Jeffrey D. Henderer, M.D., American Academy of Ophthalmology Secretary for Curriculum Development, serves as the overall project director for the acquisition and review of the topic outlines.

The Academy gratefully acknowledges the contributions of the American Association for Pediatric Ophthalmology and Strabismus.

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Background on Maintenance of Certification (MOC)

Developed according to standards established by the American Board of Medical Specialties (ABMS), the umbrella organization of 24 medical specialty boards, Maintenance of Certification (MOC) is designed as a series of requirements for practicing ophthalmologists to complete over a 10-year period. MOC is currently open to all Board Certified ophthalmologists on a voluntary basis; time-limited certificate holders (ophthalmologists who were Board Certified after July 1, 1992) are required to participate in this process. All medical specialties participate in a similar process.

The roles of the American Board of Ophthalmology (ABO) and the American Academy of Ophthalmology relative to MOC follow their respective missions.

- The mission of the American Board of Ophthalmology is to serve the public by improving the quality of ophthalmic practice through a process of certification and maintenance of certification that fosters excellence and encourages continual learning.

- The mission of the American Academy of Ophthalmology is to protect sight and empower lives by serving as an advocate for patients and the public, leading ophthalmic education, and advancing the profession of ophthalmology.

The role of the ABO in the MOC process is to evaluate and to certify. The role of the Academy in this process is to provide resources and to educate.

Organization of the POC

The Practicing Ophthalmologists Curriculum comprises 10 practice emphasis areas (PEA), plus Core Ophthalmic Knowledge.

- Core Ophthalmic Knowledge (a required segment for the ABO's MOC examinations.)
- Comprehensive Ophthalmology
- Cataract/Anterior Segment
- Cornea/External Disease
- Glaucoma
- Neuro-Ophthalmology and Orbit
- Oculoplastics and Orbit
- Pediatric Ophthalmology/Strabismus
- Refractive Management/Intervention
- Retina/Vitreous
- Uveitis

In addition to two practice emphasis areas of choice, every diplomate sitting for the DOCK examination will be tested on Core Ophthalmic Knowledge. The ABO defines Core Ophthalmic Knowledge as fundamental knowledge every practicing ophthalmologist should have regardless their practice focus.

Each PEA is categorized into topics presented in an outline format for easier reading and understanding. These outlines are based on a standard clinical diagnosis and treatment approach found in the Academy's Preferred Practice Patterns. For each topic, there are Additional Resources that may contain journal citations and reference to textbooks that may be helpful in preparing for MOC examinations.

Creation of the POC

The POC was developed by panels of Academy members who are practicing ophthalmologists in each of the ten practice emphasis areas. The panels reflect a diversity of background, training, practice type and geographic distribution. Additionally, all panel members are time-limited certificate holders actively participating in the MOC process.

The panels have reviewed the ABO's content outlines for the MOC examinations and developed and clinical review topics that they feel are most likely to appear on MOC examinations. These clinical topics also were reviewed by representatives from each subspecialty society.

Revision Process

The POC is revised every three years. The POC panels will consider new evidence in the peer-reviewed literature, as well as input from the subspecialty societies, and the Academy's Self-Assessment Committee, in revising and updating the POC.

Prior to a scheduled review the POC may be changed under the following circumstances:

- A Level I (highest level of scientific evidence) randomized controlled trial indicates a major new therapeutic strategy
- The FDA issues a drug/device warning
- Industry issues a warning

Cataract/Anterior Segment

Diagnostic Tests

Anterior Segment Disorders

Types of Cataracts

Anesthesia/Infection Prophylaxis/Viscosurgical Devices

Surgical Techniques/Instrumentation

Intraocular Lenses/IOL Implantation

Intraoperative Complications

Postoperative Complications

Cataract Surgery in Special Situations

Evaluation of reduced vision not fully explained by degree of cataract

I. List the indications/contraindications

A. Indications

1. Degree of cataract does not correspond with best corrected visual acuity (BCVA) or visual function

II. Common reasons for visual loss not fully explained by degree of cataract

A. Poor/inaccurate refraction

B. Tear film abnormality

C. Corneal pathology

1. Keratoconus or irregular astigmatism
2. Corneal opacity
3. Corneal dystrophies i.e. Fuchs corneal dystrophy

D. Retinal pathology

1. Macular degeneration
2. Diabetic retinopathy
3. Retinal vein/artery occlusion
4. Macular edema
5. Epiretinal membrane
6. Vitreomacular traction
7. Macular hole
8. Parafoveal telangiectasia
9. Solar retinopathy

E. Optic nerve pathology

1. Glaucoma
2. Optic neuropathy

F. Amblyopia

G. Non organic visual loss

III. Describe evaluation

A. Clinical history

B. Visual acuity testing with refraction and attention to myopic shift

C. Slit-lamp biomicroscopic examination and undilated and dilated funduscopic examination

1. The amount of cataract can be underestimated with dilated view

D. Comprehensive eye examination

IV. Describe the instrumentation and technique

A. Pupil light reflex test

B. Corneal topography

C. Corneal pachymetry and spectral microscopy

D. Visual field testing

E. Fluorescein angiography

1. Contraindicated if the patient has a severe reaction to fluorescein dye

F. Potential acuity testing

G. Near vision testing/pinhole testing

H. Electroretinogram

I. Wavefront analysis

J. Optical coherence tomography, if available

K. Dye testing for corneal stain(dry eye)

L. Prism test

M. Bruckner test

V. List the complications of this procedure, their prevention and management

A. Fluorescein angiography

1. Complications
   a. Urticarial reactions
   b. Anaphylactic reactions, nausea/vomiting
2. Prevention
   a. Careful history
   b. Premedicate with antihistamine and/or corticosteroid
3. Management
   a. Urticarial reaction - antihistamine and/or corticosteroid
   b. Anaphylactic reaction - epinephrine, IV fluids, intubation

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Estimation of intraocular lens power

I. List the indications/contraindications

A. Indications

1. Calculation of intraocular lens (IOL) power required for surgical correction of refractive error
2. Evaluation for anisometropia

B. Contraindication

1. Open globe injury

II. Describe the pre-procedure/therapy evaluation

A. Measurement of corneal refractive power (keratometry)

1. Values obtained with manual or automated keratometry, topography, IOL master or Lenstar technology
2. None of these methods reliably determine central corneal power following keratorefractive procedures, resulting in unanticipated refractive outcomes without compensatory adjustments

B. Measurement of axial length (biometry)

1. Contact A-scan ultrasound
    a. Topical anesthesia
    b. Care taken not to indent the cornea
2. Non-contact methods
    a. Immersion A-scan ultrasound
        i. Topical anesthesia
        ii. Water bath
        iii. Shell
    b. Laser interferometry (e.g. IOL master or Lenstar technology)
        i. No anesthesia
        ii. No contact with the eye
        iii. Increased reproducibility, ease, and speed of measurements
        iv. Increased accuracy secondary to measurement of refractive rather than anatomic axial length
        v. May not work in eyes with certain types of cataracts (dense PSC, mature cataract)

III. List the possible sources of errors in measurement, their prevention and management

A. Keratometry

1. Poor fixation (e.g. mature cataract, macular hole, strabismus, patient cooperation or understanding)
    a. Fixation target, coaching
2. Corneal findings
    a. Abnormal tear film
        i. Optimize ocular surface prior to measurement
    b. Prior keratorefractive surgery
        i. Requires estimation of corneal power by methodology appropriate for the type of

keratorefractive surgery performed

c. Pterygium, corneal scarring, prior PKP, nodules

i. Consider RGP over-refraction

3. Iatrogenic (e.g. poorly calibrated manual keratometer, trial lens in front of manual keratometer)

4. Contact lens wear

a. Patient should have minimum 1-week contact lens holiday prior to measurements. Consider longer period if long-term rigid gas permeable wear.

B. Biometry

1. Poor fixation or failure to find the visual axis accurately (e.g. high myopes +/- posterior staphyloma)

a. Optical methods (laser interferometry) better for measuring axial length in cases of staphyloma

b. Consider B-scan ultrasonography

2. Corneal compression from contact A-scan can cause inaccurate measurement (underestimate) of axial length

a. Consider non-contact biometry methods

3. Dense cataract or posterior subcapsular cataract can cause decreased accuracy when measuring with laser interferometer

a. Consider contact or immersion biometry

4. Silicone oil can cause inaccurate measurement (overestimate) of axial length when measuring with ultrasound

a. Consider optical methods

C. Steps to minimize inaccuracies include:

1. Measure both eyes

2. Repeat keratometry if:

a. Average corneal power for any eye is less than 41 D or greater than 47 D

b. Greater than 0.5 D difference in average power between eyes

c. Astigmatism for any eye is greater than 3.0 D

3. Repeat biometry if:

a. Axial length less than 22.0

b. Axial length greater than 25.0

c. Greater than 0.3 mm difference between eyes

4. Clinical correlation is required to explain all significant differences in average keratometry or axial length values

IV. Describe the considerations in interpretation for this diagnostic procedure

A. Examine quality of scans

B. Examine reproducibility

C. Compare both eyes

D. Look for correlation with refraction

E. Describe appropriate character of good spikes

F. Special consideration in eyes with silicone oil, prior keratorefractive surgery

V. IOL Formulas

A. First generation (obsolete)

1. SRK

2. P = A-0.9 K - 2.5 L

B. Second generation (obsolete)

1. SRK II

2. A constant modified based on the axial length

C. Third generation

1. Holladay

    a. Best for axial lengths 24-26 mm

2. Hoffer Q

    a. Consider for short axial lengths

3. SRK-T

    a. Consider for long axial lengths

D. Fourth generation

1. Haigis, Holliday II, Olsen

2. Incorporate additional measurements (anterior chamber depth, lens thickness, and horizontal corneal diameter)

3. Improved accuracy in predicting the effective lens position of the IOL to be implanted

4. Improved accuracy of IOL calculations in cases of previous keratorefractive surgery

E. Optimization of lens constants for a specific IOL based on an individual surgeon's actual refractive outcome is recommended

F. Eyes with prior keratorefractive surgery (See Intraocular lens calculation following refractive surgery)

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.

3. Hennessy MP, Franzco, Chan DG. Contact versus immersion biometry of axial length before cataract surgery. J Cataract Refract Surg 2003; 29:2195-8.

4. AAO, Focal Points: Refractive Lens Exchange, Module #6, 2007.

Evaluation of glare disability: subjective and objective

I. List the indications/contraindications

A. Indications

1. Patient complains of glare symptoms
    a. Difficulty driving toward sunlight
    b. Difficulty driving toward oncoming traffic at night
2. Evaluate effect of cataract on functional vision i.e. when Snellen acuity is good, but the patient's complaints are significant, thus determining if there is an indication for cataract surgery
3. Evaluate effect of "secondary membrane" on vision
4. Evaluate effect of corneal abnormality on vision

II. Describe the pre-procedure evaluation

A. Clinical history of glare symptoms and functional deficits

B. Comprehensive eye examination

C. Documentation of symptoms

III. Describe the instrumentation, anesthesia, and technique

A. Brightness acuity tester (BAT)

1. Test of Snellen letter acuity
2. Three levels of background illumination (low, medium, high)

B. Snellen acuity testing with penlight obliquely aimed at pupil

C. Contrast sensitivity testing

1. With and without glare light source
2. Photopic and mesopic lighting

IV. Describe the considerations in interpretation for this diagnostic procedure

A. No uniform standards have been established for the various devices

B. Results can vary according to brightness of illumination source

C. Test is not specific for cataract

D. False positive results may be achieved due to dazzle of bright light sources

E. False negative result may be achieved because some patients with cataract may perform better with pupil constriction from bright light

F. If testing corroborates the patient's symptoms with objective findings that glare decreases vision to the point that it interferes with activities of daily living (e.g., affects driving ability), then cataract surgery should be discussed

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.8-9.

Iridodialysis

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Trauma (accidental) or iatrogenic (surgical)

B. List the pertinent elements of the history

1. History of trauma to globe, inadvertent or surgical
2. Glare symptoms
3. Photophobia
4. Monocular diplopia

C. Describe pertinent clinical features

1. Separation of the iris root from the ciliary body
2. Iris defect (peripheral)
3. Possible hyphema (acutely)
4. Abnormal intraocular pressure (IOP)
    a. High, if damage to trabecular meshwork occurs
    b. Low, if a concomitant cyclodialysis occurs
5. Abnormal pupil: irregular, nonreactive, segmental irregularity, fixed, and/or dilated
6. Other evidence of trauma (e.g., co-incident zonular dialysis) or surgery

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Slit- lamp biomicroscopic exam
2. Gonioscopy
3. Transillumination
4. Tonometry

II. Define the risk factors

A. Trauma

B. Surgery

III. List the differential diagnosis

A. Iridocorneal endothelial syndrome

B. Iris coloboma

C. Axenfeld Rieger syndrome

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Sunglasses to decrease glare and photophobia
2. Contact lenses with artificial iris/pupil

3. Pharmacological treatment
    a. Miotics for mydriasis.
    b. IOP lowering agents for ocular hypertension
    c. Steroids, mydriatics for hyphema

B. Describe surgical therapy options

1. Repair by suturing peripheral iris to sclera
2. Aniridic implant devices with cataract surgery (Not FDA approved))
3. Corneal tattooing (small dialysis)

V. List the complications of treatment, their prevention and management

A. Contact lens associated hypoxia, abrasions, infiltrates, ulcers

B. Complications related to anterior segment surgery

VI. Describe disease-related complications

A. Glaucoma

B. Hypotony

VII. Describe appropriate patient instructions

A. Regular follow-up to monitor IOP

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016

Lens-induced glaucoma - phacolytic

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Hydration of the lens material creates intumescent cataract/hypermature cataract
2. Soluble high molecular weight lens proteins leak through grossly intact lens capsule
3. Lens proteins are ingested by macrophages
4. Secondary open angle glaucoma due to macrophages in aqueous blocking the trabecular meshwork and increases intraocular pressure

B. Define the relevant aspects of epidemiology of this disease

1. Age
2. Delay in obtaining timely cataract surgery

C. List the pertinent elements of the history

1. Progressive loss of vision, often over a long course
2. Red eye
3. Pain in eye and brow

D. Describe pertinent clinical features

1. Large cells, debris and flare in anterior chamber
    a. Iridescent or hyper-refringent particles. These represent calcium oxalate and cholesterol crystals released from the degenerating cataract
2. Hypermature lens may have wrinkled capsule or calcium deposition
3. Perilimbal conjunctival inflammation
4. High IOP
5. Microcystic corneal edema without keratic precipitate
6. White flocculent material appears in the anterior chamber and angle

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. B scan ultrasound
2. Consider hemoglobin A1c (HgbA1c) or fasting blood glucose to rule out diabetes mellitus in younger patients

II. Define the risk factors

A. Smoking

B. Ultraviolet light exposure

C. Diabetes mellitus

D. Poor nutrition

E. Trauma

III. List the differential diagnosis

A. Uveitis

B. Posner-Schlossman syndrome

C. Fuchs heterochromic iridocyclitis

D. Neovascular glaucoma

E. Ocular ischemic syndrome

F. Masquerade syndrome

G. Lens Particle Glaucoma

H. Phacoantigenic uveitis

I. Endogenous endophthalmitis

IV. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options (temporary to stabilize until surgery)

1. Initial therapy with aqueous suppressants
2. Corticosteroids

B. Define surgical therapy options

1. Definitive treatment is phacoemulsification/extracapsular cataract extraction
    a. Capsular staining techniques
    b. Capsulorrhexis techniques
        i. Initial small tear
        ii. Removal of liquid cortical material
        iii. Use of ophthalmic viscosurgical device (viscoelastic) to flatten anterior capsule to lower risk of radial tear
    c. Carefully irrigate to remove all lens material

V. List the complications of treatment, their prevention and management

A. Complications of surgery

1. Increased risk of capsular radial tear
2. Increased risk of vitreous loss
3. Increased risk of zonular dialysis
4. Increased risk of loss of lens into the vitreous
5. Suprachoroidal hemorrhage

VI. Describe disease-related complications

A. Vascular occlusion

B. Glaucomatous damage to the optic nerve

C. Chronic inflammation

VII. Describe appropriate patient instructions

A. Risks and benefits of cataract surgery

B. Risks of untreated phacolytic glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, p. 58.

Lens-induced glaucoma - lens particle

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Ruptured lens capsule allows release of large lens particles
    a. Following penetrating trauma
    b. Retained material after lens surgery
2. A type of secondary open-angle glaucoma involving intraocular retention of fragmented lens debris
    a. Obstruction of trabecular meshwork by lens debris
    b. Reduction of the outflow facility of an open anterior chamber angle with elevation of intraocular pressure

B. List the pertinent elements of the history

1. Red, inflamed, possibly painful eye
2. History of trauma, past eye surgery or past laser capsulotomy

C. Describe pertinent clinical features

1. Variable ocular inflammatory response (often asymptomatic)
2. Elevated intraocular pressure
3. Lens material in anterior chamber (AC)
4. Inflammatory anterior synechiae later in severe disease
5. Vitreal lens fragments in cases of dislocated nucleus

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. B scan ultrasound or computed tomography
    a. Torn posterior capsule
    b. Rule out intraocular foreign body or locate nuclear fragment
    c. Possible a/c or vitreal tap
2. Gonioscopy to locate lens material in angle

II. Define the risk factors

A. Penetrating trauma

B. Loss of lens material (retained lens material) during cataract surgery

III. List the differential diagnosis

A. Uveitis

B. Masquerade syndrome

C. Endophthalmitis

D. Intraocular foreign body

E. Other secondary glaucomas

IV. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Temporary to stabilize until surgery
    a. Aqueous suppressants
    b. Corticosteroids

B. Define surgical therapy options

1. Traumatic lens particle
    a. Phacoemulsification/extracapsular cataract extraction to remove residual lens material
    b. Capsular staining to identify traumatic tear
    c. No hydrodissection if posterior penetration suspected
    d. Usually can aspirate lens material in younger patients without need for nucleofractis phacoemulsification
2. Retained lens material following surgery
    a. Use irrigation aspiration device to remove residual material in AC
    b. Pars plana vitrectomy for posterior displaced lens fragments

V. List the complications of treatment, their prevention and management

A. Traumatic lens particle -- complications of cataract surgery

1. Increased risk of anterior radial capsular tear
2. Increased risk of vitreous loss
3. Increased risk of lens material in vitreous
4. Increased risk of retinal detachment

B. Retained lens material-risk of intraocular surgery

1. Reoperation increases risk of endophthalmitis

VI. Describe disease-related complications

A. Glaucomatous damage to optic nerve

B. Chronic uveitis

C. Vascular occlusion

D. Corneal decompensation

VII. Describe appropriate patient instructions

A. Risks and benefits of surgery to remove lens particles

B. Risks of glaucoma and inflammation from retained lens particles

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 58.

Lens-induced glaucoma - phacomorphic

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Enlarging intumescent nuclear cataract or mixed cataract with crowding of the iridocorneal angle
2. Cataract causes angle closure glaucoma
    a. Pupillary block
    b. Shallowing of peripheral anterior chamber

B. Define the relevant aspects of epidemiology of this disease

1. Hyperopia associated with small anterior segment
    a. Especially with progressive myopic shift
2. Short axial length
3. Nanophthalmos
4. Advancing age
5. Cigarette smoking increases the risk of nuclear sclerosis

C. List the pertinent elements of the history

1. Gradual progressive loss of vision (due to cataract)
2. Acute pain, rainbow-colored halos, blurred vision, nausea and vomiting (due to angle closure)

D. Describe pertinent clinical features

1. High intraocular pressure
2. Corneal edema
3. Mid-dilated, irregular pupil
4. Nuclear or mixed cataract
5. Shallow anterior chamber
6. Closed angle or Peripheral Anterior Synechiae on gonioscopy

E. Describe the appropriate testing and evaluation for establishing the diagnosis

1. Gonioscopy, ultrasound biomicroscopy and anterior segment optical coherence tomography can be used to evaluate the angle before and after treatment

II. Define the risk factors

A. Hyperopia, small anterior segment, short axial length

B. Traumatic cataract (accidental or iatrogenic)

C. Intumescent cataract

D. Pseudoexfoliation

III. List the differential diagnosis

A. Primary angle closure glaucoma

B. Plateau iris glaucoma

C. Iris/ciliary body/pars plana/posterior tumor or mass causing angle closure

IV. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Aqueous suppressants
2. Miotics avoided due to forward movement of the lens/iris diaphragm

B. Define surgical therapy options

1. Laser peripheral iridotomy
2. Phacoemulsification/extracapsular cataract extraction - early intervention justified

V. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of corneal edema with shallow chamber and hard nucleus

VI. Describe disease-related complications

A. Retinal vascular occlusion

B. Glaucomatous optic nerve damage

VII. Describe appropriate patient instructions

A. Risks and benefits of cataract surgery

B. Risks of untreated glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 58.

Traumatic cataract

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Contusive ocular trauma
2. Penetrating ocular injury
    a. With lens capsule rupture
    b. Without lens capsule rupture
3. Other causes
    a. Ionizing radiation
    b. Electrical shock
    c. Chemical injury
    d. Surgical trauma
        i. Phakic IOL (poor sizing, capsular contact)
        ii. Inadvertent lens capsule injury during intraocular surgery or injection

B. List the pertinent elements of the history

1. Recent or distant trauma
2. History of exposure to known causative agents
3. Previous intraocular surgery

C. Describe pertinent clinical features

1. A focal or diffuse fluffy white cortical cataract usually develops minutes to days after penetrating ocular injury with capsule rupture
    a. Risk of lens particle or phacoantigenic glaucoma
2. A mixed anterior subcapsular and cortical cataract usually develops weeks to months after severe ocular injury without lens capsule rupture ("Rosette" cataract)
3. A mixed nuclear and cortical cataract usually develops months to years after contusive ocular injury
    a. A Vossius ring may be present
    b. Progression to a mature or hypermature state is common
        i. Risk of phacolytic, phacomorphic glaucoma
4. Zonule damage may result in vitreous prolapse, phacodonesis, lens subluxation or complete dislocation of a traumatized lens
5. Iris damage is often present
    a. Iris sphincter tears after contusive injury
    b. Iridodialysis
    c. Traumatic mydriasis
    d. Focal transillumination defect
        i. Should prompt workup for retained intraocular foreign body

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Slit-lamp biomicroscopy
    a. Consider gonioscopy to check for angle recession or retained foreign body
2. Ultrasound of the posterior segment should be performed if the posterior segment cannot be visualized

II. Define the risk factors

A. Male gender

B. High-risk occupations without appropriate safety eyewear (such as machine shop, woodworking, bungee cord use)

C. Contact sports (such as boxing)

D. Motor vehicle accidents (such as shattered glass, air bag injury)

E. Domestic violence

III. Surgical timing

A. Intraocular inflammation, hemorrhage and pressure should be well controlled prior to surgical intervention

1. Complete resolution of hyphema, microhyphema or traumatic iritis
2. Stable intraocular pressure
3. Exceptions to this rule include phacolytic and lens particle glaucoma which require urgent cataract removal if intraocular pressure cannot be controlled medically

IV. List the surgical challenges for which the patient is at increased risk

A. Be prepared for and maintain a high level of suspicion for concomitant ocular damage

B. Difficulties with capsulorrhexis

1. Subcapsular fibrosis is often encountered and sometimes requires scissors to complete anterior capsular opening
2. Trypan blue can help visualize the anterior capsule if the lens is mature or significant fibrosis or cortical opacities are present
    a. In cases of known zonulopathy, care should be taken to prevent inadvertent injection of Trypan blue into the posterior segment

C. Zonular weakness

1. Capsular retractors can be used along the margin of an intact capsulorrhexis to stabilize the bag
    a. Iris hooks
    b. Specially designed capsular hook/retractors are available
2. If the zonular weakness is 1-4 clock hours, a capsular tension ring (CTR) can be utilized
    a. Insertion of the CTR should be performed as late in the case as possible, but as early as is necessary
3. If zonular weakness is >4 clock hours, a scleral-fixated CTR can be utilized

D. Vitreous prolapse

1. Focal vitreous prolapse around an area of zonular weakness can often be tamponaded with viscoelastic
    a. "slow motion" phaco settings (reduced bottle height, vacuum and aspiration) must be utilized to prevent premature removal of the viscoelastic
2. Diffuse vitreous prolapse needs to be dealt with before proceeding with phacoemulsification
    a. Anterior vitrectomy via the pars plana is advocated by some for this indication

E. Iris damage

1. Iridodialysis repair if large
2. Iris sphincter tear repair if large
3. Atonic/mydriatic pupil must be repaired if the pupil will not allow 360 coverage of IOL optic to prevent

debilitating glare and haloes

4. Artificial iris segments of appropriate type if loss of iris tissue present

F. IOL placement

1. Capsular support sufficient
    a. Capsular bag
    b. Sulcus fixation
2. Capsular support insufficient
    a. Iris or scleral fixation
    b. ACIOL

V. List the implications of the high-risk characteristics on the long-term results

A. Visual outcome typically determined by extent of other traumatic injuries

1. Corneal scar
2. Macular hole
3. Choroidal rupture
4. Retinal detachment
5. Traumatic optic neuropathy

B. IOL decentration or dislocation more common

C. Increased risk of traumatic glaucoma

1. Requires lifelong surveillance following severe contusive ocular injury

VI. Describe how follow up instructions and care differs from routine surgery

A. Same as for standard cataract surgery

B. Close IOP monitoring

C. Close retinal monitoring

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Mian SI, Azar DT, Colby K. Management of traumatic cataracts. *Int Ophthalmol Clin* 2002 Summer;42(3):23-31.
3. Dannenberg AL, Parver LM, Brechner RJ, Khoo L. Penetration eye injuries in the workplace. The National Eye Trauma System Registry. *Arch Ophthalmol* 1992 Jun;110(6):843-8
4. Kwitko ML, Kwitko GM. Management of the traumatic cataract. *Curr Opin Ophthalmol* 1990 Feb;1(1):25-7.

Anterior polar cataracts

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Opacity of the anterior subcapsular cortex and capsule
2. Frequently autosomal dominant

B. List the pertinent elements of the history

1. Usually asymptomatic
2. Symptoms of glare

C. Describe pertinent clinical features

1. Good vision
2. Central opacity involving the anterior capsule
3. Bilateral
4. Nonprogressive usually

II. List the differential diagnosis

A. Penetrating capsule trauma

B. Traumatic stellate cataract

C. Anterior lenticonus

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Eyeglasses or contact lenses

B. Define surgical therapy options

1. Phacoemulsification/extracapsular cataract extraction
    a. Capsulorrhexis may be challenging as the anterior capsule is often attached to the anterior polar cataract
        i. Begin capsule tear away from polar cataract
        ii. Enlarge and encompass polar cataract if possible
        iii. Consider use of capsule staining

IV. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of radial capsular tear

V. Describe appropriate patient instructions

A. Risks and benefits of cataract surgery

1. Careful discussion of greater risks for capsule rupture and sequelae

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. AAO, Ophthalmology Monographs 30. A Compendium of Inherited Disorders and the Eye, 2006.

Posterior polar cataracts

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Thickened, geometric opacity of the posterior subcapsular cortex and capsule with possible capsule defect
2. Familial autosomal dominant bilateral ; sporadic unilateral
3. Slowly progressive

B. List the pertinent elements of the history

1. Nodal point location; symptomatic earlier in life
2. Generally becomes more symptomatic with the onset of presbyopia

C. Describe pertinent clinical features

1. Vision worse with miosis
    a. Near vision (accommodative effort) worse than distance vision
    b. Vision in bright light worse than dim light
2. Glare
3. Central elevated, thickened opacity involving the posterior pole of the lens

II. List the differential diagnosis

A. Posterior subcapsular cataract

B. Penetrating capsule trauma

C. Mittendorf dot

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Mydriatic (possible role as a temporizing agent)
2. Eyeglasses and contact lenses

B. Define surgical therapy options

1. Phacoemulsification/extracapsular cataract extraction (ECCE)
    a. Avoid excessive intracapsular pressure
        i. Avoid complete hydrodissection, but "segmental" hydrodissection with small amounts of fluid around cortex and up to the opacity may be useful
        ii. hydrodelineation may help to mobilize nucleus from epinuclear bowl
        iii. Femtosecond-assisted cataract surgery may produce bubbles that could damage posterior capsule
        iv. Pre-chopping of lens should be avoided
    b. After nucleus is removed, use dispersive OVD to visco dissect the epinucleus from the bag
    c. Alter fluidic exchange during surgery - "slow motion" concept with relatively lower bottle height and lower vacuum

IV. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of posterior capsular tear; occurs in 1/4 of cases
2. Increased risk of vitreous loss
3. Increased risk of loss of lens material into vitreous

V. Describe appropriate patient instructions

A. Risk and benefit of cataract surgery

B. Careful discussion of greater risks for capsule rupture and sequelae

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.
4. AAO, Ophthalmology Monographs 31. A Compendium of Inherited Disorders and the Eye, 2006.
5. http://webeye.ophth.uiowa.edu/eyeforum/cases/128-Posterior-Polar-Cataract.htm

Ectopia lentis

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Displacement of the lens
    a. Subluxed which implies partial zonular integrity as the lens is only partially displaced and within the pupillary aperture
    b. Luxated with total loss of zonule attachments with the lens completely dislocated from the pupil
2. Congenital, developmental, or acquired

B. Define the relevant aspects of epidemiology of this disease

1. Traumatic most common
2. Greater than 50% of patients with Marfan syndrome exhibit ectopia lentis

C. List the pertinent elements of the history

1. Decreased vision
2. Monocular diplopia
3. Glare
4. Poor near vision
5. History of trauma, chronic uveitis, Marfan syndrome, homocystinuria, Weil-Marchesani syndrome, hyperlysinemia or sulfite oxidase deficiency

D. Describe pertinent clinical features

1. Subluxation or total luxation of the lens
2. Phacodonesis
3. Marked lenticular astigmatism
4. Iridodonesis
5. Anterior dislocation into chamber or causing pupillary block
6. Amblyopia
7. Impaired accommodation

II. Define the risk factors and differential diagnosis

A. Traumatic (See Traumatic dislocation and subluxation)

B. Non-traumatic

1. Primarily ocular
    a. Pseudoexfoliation
    b. Simple ectopia lentis
    c. Ectopia lentis et pupillae
    d. Aniridia
    e. Congenital glaucoma
    f. Chronic uveitis
2. Systemic
    a. Marfan syndrome

b. Homocystinuria

c. Weil-Marchesani syndrome

d. Hyperlysinemia

e. Sulfite oxidase deficiency

f. Microspherophakia

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Eyeglasses for subluxed lenses
2. Aphakic contact lens in cases of significant subluxation or luxation

B. Define surgical therapy options

1. Intracapsular cataract extraction
2. Phacoemulsification/extracapsular cataract extraction
   a. Attend to any vitreous in anterior chamber
   b. Stabilization of capsule with hooks
   c. Capsular tension ring (CTR) with or without modification to allow scleral suture
   d. CTR with capsular tension segment sutured to the sclera
3. Pars plana lensectomy and vitrectomy
4. Rehabilitation following lens removal
   a. Intraocular lens (IOL) in bag - mild cases or aided by CTR
   b. Iris fixated IOL
   c. Angle supported IOL
   d. Scleral fixated posterior chamber IOL
   e. Contact lens or eyeglasses

IV. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of vitreous loss
2. Increased risk of loss of lens material into vitreous
3. Increased risk of retinal detachment

V. Describe disease-related complications

A. Pupillary block glaucoma

B. Systemic complications of Marfan syndrome, homocystinuria, etc.

VI. Describe appropriate patient instructions

A. Genetic counseling in nontraumatic cases

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Por YM, Lavin MJ. Techniques of intraocular lens suspension in the absence of capsular/zonular support.. Surv Ophthalmol. 2005 Sep-Oct;50(5):429-62.

Nuclear cataracts

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Hardening and yellowing of the central lens fibers
2. Advanced nuclear sclerosis leads to brown dense brunescent nucleus
3. Protein density and composition changes

B. Define the relevant aspects of epidemiology of this disease

1. Age
2. Female gender
3. Cigarette smoking
4. Lower education levels
5. Family history

C. List the pertinent elements of the history

1. Gradual progressive loss of vision
2. Myopic shift
3. Monocular diplopia
4. Decreased color discrimination
5. Decreased contrast sensitivity

D. Describe pertinent clinical features

1. Central yellow to brown discoloration of the lens
2. Myopic shift
3. Bilateral (typically)
4. Decreased clarity of fundus details due to blur from cataract
5. Relative shallowing of the anterior chamber

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Complete eye exam including slit lamp biomicroscopy
2. Glare testing

II. Define the risk factors

A. Trauma -- asymmetric nuclear sclerosis

B. Smoking

C. Medications

D. Intraocular surgery (especially prior pars plana vitrectomy)

E. High myopia

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Optimize eyeglasses/ contact lenses

B. Define surgical therapy options

1. Phacoemulsification/ extracapsular cataract extraction

IV. Describe disease-related complications

A. Progressive vision loss

B. Lens induced glaucoma

C. Consecutive strabismus (e.g. exotropia)

V. Describe appropriate patient instructions

A. Risks and benefits of cataract surgery

B. Lighting for reading

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.16-18.
3. AAO, Preferred Practice Pattern. Cataract in the Adult Eye. AAO. 2014
4. Chang JR, et al. Risk factors associated with incident cataracts and cataract surgery in the Age-related Eye Disease Study (AREDS): AREDS report number 32. Age-Related Eye Disease Study Group. Ophthalmology. 2011 Nov;118(11):2113-9.

Intumescent cortical cataract

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Opacification of the cortical lens fibers
2. Swelling of the lens cortex creates intumescent cataract

B. List the pertinent elements of the history

1. Progressive loss of vision, often rapid
2. Glare
3. Monocular diplopia
4. Failure to have comprehensive eye examination and management of cataract at earlier stage of development

C. Describe pertinent clinical features

1. Initially vacuoles and water cleft in the lens cortex
2. Wedge shaped opacities or cortical spokes
3. Progresses to form white intumescent cortical cataract
4. Raised intracapsular tension may cause bulging of anterior capsule into pupil

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Demonstrate light projection in all four quadrants to establish relative retinal function
2. B scan ultrasound to evaluate posterior segment if necessary
3. Hemoglobin A1c (HgbA1c) or fasting blood glucose to rule out diabetes mellitus

II. Define the risk factors

A. Smoking

B. Ultraviolet light exposure

C. Diabetes mellitus

D. Poor nutrition

E. Trauma

F. Intraocular surgery

G. Uveitis

H. Angle-closure

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Observation

B. Define surgical therapy options

1. Phacoemulsification / extracapsular cataract extraction
    a. Capsular staining techniques (See Capsule staining)
    b. Capsulorrhexis techniques

i. Small central puncture of capsule with removal of liquid cortical material to relieve capsular tension

ii. Liberal use of ophthalmic viscosurgical device (viscoelastic)

IV. List the complications of treatment, their prevention and management

A. Complications of surgery

1. Increased risk of capsular radial tear
2. Increased risk of vitreous loss
3. Increased risk of loss of lens material into vitreous

V. Describe disease-related complications

A. Phacolytic glaucoma

B. Phacomorphic glaucoma

VI. Describe appropriate patient instructions

A. Risk and benefit of cataract surgery

B. Risk of phacolytic glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Focal Points: Strategies for Complicated Lens Surgery, Module #8, 2005.

Hypermature cataract

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Opacification of the cortical lens fibers
2. Swelling of the lens material creates intumescent cataract
3. Degenerated cortical material leaks through capsule leaving wrinkled capsule

B. Define the relevant aspects of epidemiology of this disease

1. Age
2. Trauma
3. Smoking
4. Intraocular surgery
5. Corticosteroid use
6. Diabetes mellitus
7. Uveitis
8. Poor nutrition

C. List the pertinent elements of the history

1. Prior trauma, surgery, or eye disease
2. Progressive protracted loss of vision
3. Photophobia if phacolysis occurs
4. Redness if phacolysis occurs

D. Describe pertinent clinical features

1. No red reflex / no fundus view
2. May have phacolytic glaucoma or inflammation
3. May have shallow anterior chamber
4. Wrinkled anterior capsule
5. Increased anterior chamber flare
6. Calcium deposits in lens
7. White cortical material

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. B scan ultrasound to rule out retinal detachment or tumor
2. Consider hemoglobin A1c (HgbA1c) or fasting blood glucose to rule out diabetes mellitus

II. Define the risk factors

A. Smoking

B. Ultraviolet light exposure

C. Diabetes mellitus

D. Poor nutrition

E. Trauma

F. Intraocular surgery

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Topical corticosteroids to decrease inflammation

B. Define surgical therapy options

1. Phacoemulsification/extracapsular cataract extraction
    a. Capsular staining techniques (See Capsule staining)
    b. Capsulorrhexis techniques
        i. Use of high viscosity ophthalmic viscosurgical device (viscoelastic) in anterior chamber to flatten anterior capsule
        ii. Removal of liquid cortical material
        iii. Add more viscoelastic to flatten dome of anterior capsule
        iv. consider femtosecond laser to create capsulorrhexis

IV. List the complications of treatment, their prevention and management

A. Complications of surgery

1. Increased risk of anterior and posterior capsular radial tear (Argentinian flag sign).
2. Increased risk of vitreous loss
3. Increased risk of zonular dialysis
4. Increased risk of subluxated or luxated crystalline lens

V. Describe disease-related complications

A. Phacolytic glaucoma

B. Consecutive strabismus (e.g., exotropia)

C. Phacomorphic glaucoma

D. Subluxated intraocular lens

VI. Describe appropriate patient instructions

A. Risk and benefit of complex cataract surgery

B. Risk of phacolytic glaucoma with postponing surgery

C. Consecutive exotropia can result and may prevent fusion in future, leading to diplopia

D. Unable to evaluate posterior segment

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Morgagnian cataract

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Opacification of the cortical lens fibers
2. Can be swelling of the lens material as in intumescent cataract
3. Can be wrinkled capsule as in hypermature cataract
4. Hallmark -- liquified cortex allows nucleus to move freely in bag

B. List the pertinent elements of the history

1. Progressive loss of vision
2. Typically has had poor vision for years in affected eye

C. Describe pertinent clinical features

1. Wrinkled anterior capsule
2. Increased anterior chamber flare
3. Dense brown nucleus freely moving in capsular bag
4. Calcium deposits within the lens

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Slit-lamp biomicroscopy
2. B scan ultrasound

II. Define the risk factors

A. Smoking

B. Ultraviolet light exposure

C. Diabetes mellitus

D. Poor nutrition

E. Trauma

F. Delay in obtaining timely cataract surgery

III. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Observation

B. Define surgical therapy options

1. Phacoemulsification/extracapsular cataract extraction (ECCE)
    a. Capsular staining techniques (See Capsule staining)
    b. Capsulorrhexis techniques
        i. Initial small tear
        ii. Removal of liquid cortical material
        iii. Copious use of ophthalmic viscosurgical device (viscoelastic)
    c. Often dense nucleus with need for high amounts of phacoemulsification energy

d. Consider manual expression of lens

i. Traditional large incision ECCE

ii. Manual small incision cataract extraction

IV. List the complications of treatment, their prevention and management

A. Complications of surgery

1. Increased risk of capsular radial tear
2. Increased risk of vitreous loss
3. Increased risk of zonular dialysis
4. Increased risk of loss of lens into the vitreous
5. Increased risk of postoperative corneal edema

V. Describe disease-related complications

A. Phacolytic glaucoma

VI. Describe appropriate patient instructions

A. Risks and benefits of complex cataract surgery

B. Risks of phacolytic glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.15-16.

Posterior subcapsular cataracts

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Axial opacity of the posterior cortical material with granular and plaque like opacities

B. Define the relevant aspects of epidemiology of this disease

1. Typically younger patients than with nuclear or cortical cataracts
    a. May occur in any age range
2. Prior intraocular surgery (especially pars plana vitrectomy)
3. Use of corticosteroids, topical, inhaled or systemic
4. History of intraocular inflammation
5. Prior ocular trauma
6. History or periocular radiation therapy
7. Alcoholism

C. List the pertinent elements of the history

1. Progressive loss of vision, sometimes rapid
2. Glare, halos
3. Monocular diplopia
4. Vision worse with miosis
    a. Near vision (accommodative effort) worse than distance vision
    b. Vision in bright light worse than dim light

D. Describe pertinent clinical features

1. Central opacity of the posterior cortical fibers

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Glare testing -- posterior subcapsular cataract often induces a disproportionate glare disability.
2. Visualize axial opacity with direct ophthalmoscope or with retinoscopy

II. Define the risk factors

A. Corticosteroid use

B. Diabetes Mellitus

C. Radiation

D. Uveitis

E. Retinitis pigmentosa

F. Alcoholism

G. Trauma

III. List the differential diagnosis

A. Posterior cortical cataract

B. Posterior polar cataract

C. Mittendorf dot

IV. Describe patient management in terms of treatment and follow-up

A. Define medical therapy options

1. Eyeglasses or contact lenses
2. Mydriatic agent (possible role as a temporizing agent)

B. Define surgical therapy options

1. Phacoemulsification/ extracapsular cataract extraction

V. Describe appropriate patient instructions

A. Risks and benefits of cataract surgery

B. Lighting for reading

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. Kuszak JR, Deutsch TA, Brown HG. Anatomy of aged and senile cataractous lenses. In: Albert DM, Jakobiec FA, eds. Principles and Practice of Ophthalmology. Philadelphia: Saunders; 1994:564-575.
4. Gillies MC, Kuzniarz M, Craig J, et al. Intravitreal triamcinolone-induced elevated intraocular pressure is associated with the development of posterior subcapsular cataract. Ophthalmology 2005;112:139-43.
5. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Traumatic dislocation and subluxation

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Displacement of the lens
    a. Subluxed - partially displaced within pupillary aperture with some of the zonules intact
    b. Luxated or completely displaced from the pupil with no zonules intact
2. Rapid expansion of equatorial globe loosens zonular fibers

B. List the pertinent elements of the history

1. Decreased vision
2. Monocular diplopia
3. Glare
4. Poor near vision

C. Describe pertinent clinical features

1. Sub or total luxation of the lens
2. Phacodonesis
3. Marked lenticular astigmatism
4. Iridodonesis
5. Anterior dislocation into chamber or causing pupillary block
6. Impaired accommodation

II. Define the risk factors

A. Trauma

1. More common in workplace or in sports or recreational activities where protective eyewear is not worn

III. List the differential diagnosis

A. Non-traumatic

1. Primarily ocular
    a. Pseudoexfoliation
    b. Simple ectopia lentis
    c. Ectopia lentis et pupillae
    d. Aniridia
    e. Congenital glaucoma
    f. Chronic uveitis
2. Systemic (See Ectopia lentis)

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Eyeglasses for subluxed lenses
2. Aphakic contact lens with significant subluxation or luxation

B. Describe surgical therapy options

1. Intracapsular cataract extraction
2. Phacoemulsification/ extracapsular cataract extraction
    a. Attend to any vitreous in anterior chamber
    b. Stabilization of capsule with hooks
    c. Capsular tension ring (CTR) with or without modification to allow scleral suture
    d. CTR with capsular tension segment sutured to the sclera
3. Pars plana lensectomy and vitrectomy
4. Rehabilitation following lens removal
    a. Intraocular lens (IOL) in bag - mild cases or aided by CTR
    b. Iris fixated IOL
    c. Angle supported IOL
    d. Scleral fixated posterior chamber IOL
    e. Contact lens or eyeglasses

V. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of vitreous loss
2. Increased risk of loss of lens material into vitreous
3. Increased risk of retinal detachment

VI. Describe disease-related complications

A. Pupillary block glaucoma

B. Traumatic glaucoma

VII. Describe appropriate patient instructions

A. Risk and benefits of complex cataract surgery

B. Risk of traumatic glaucoma

C. Risk of traumatic retinal detachment

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.
3. Por YM, Lavin MJ. Techniques of intraocular lens suspension in the absence of capsular/zonular support. Surv Ophthalmol. 2005 Sep-Oct;50(5):429-62.

Diabetes mellitus and cataract formation

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Increased aqueous glucose concentration drives glucose into lens
2. Increased intra-lenticular glucose is converted into sorbitol which is not permeable out of the lens capsule
3. The elevated sorbitol level creates the osmolar gradient resulting in hydration of the lens
4. Sorbitol induced lenticular hydration
    a. Decreases accommodation
    b. Changes the refractive power of the lens
    c. Generates cataract formation
    d. The enlarged lens can cause phacomorphic angle-closure glaucoma
5. Nuclear and cortical cataracts occur earlier in diabetic patients

B. Define the relevant aspects of epidemiology of this disease

1. Increased incidence of diabetes in the United States
2. Related to obesity

C. List the pertinent elements of the history

1. Progressive loss of vision, sometimes rapid
2. Glare, halos
3. Monocular diplopia

D. Describe pertinent clinical features

1. Snowflake or true diabetic cataract
    a. Bilateral
    b. Posterior and anterior subcapsular, cortical spokes and clefts
2. Typical nuclear, cortical, or posterior subcapsular cataracts

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Hemoglobin A1c (HgbA1c)
2. Fasting blood sugar

II. Define the risk factors

A. Obesity

B. Family history of diabetes mellitus

C. Chronic oral corticosteroid use

III. Describe patient management in terms of treatment and follow-up

A. Ocular imaging for high risk cases

1. Fluorescein angiography

a. Define extent of pre-existing disease

b. Identify ischemic disease in patient with vision loss exceeding cataract development

2. Optical coherence tomography

a. Define presence/absence of macular edema

B. Define medical therapy options

1. Observation

C. Define surgical therapy options

1. Phacoemulsification/ extracapsular cataract extraction

a. Standard indications for surgery

b. Standard technique

IV. List the complications of treatment, their prevention and management

A. Exacerbation of diabetic macular edema

1. Focal or grid laser surgical therapy prior to surgery if indicated

2. Possible benefit of corticosteroid and/or anti-VEGF intraocular injections before/during/after surgery

B. Exacerbation of proliferative diabetic retinopathy, neovascular glaucoma

1. Pan-retinal photocoagulation prior to surgery if indicated

C. Increased risk of cystoid macular edema

1. Pretreatment with corticosteroid and nonsteroidal anti-inflammatory drug (NSAID) drops

2. Prophylactic treatment for 1-3 months with corticosteroid and/or NSAID drops after surgery

V. Describe disease-related complications

A. Progression of cataract

1. Obscuring view of posterior pole

2. Phacolytic glaucoma

B. Diabetic retinopathy - worsening with surgery

C. Neovascular glaucoma

VI. Describe appropriate patient instructions

A. Risk and benefit of cataract surgery

B. Careful follow-up for macular edema

C. Emphasize good control of blood glucose

D. Help to ensure patient is receiving care from internist or family medical doctor

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.22-23.

3. Flynn HW Jr, Smiddy WE, eds. Diabetes and Ocular Disease: Past, Present, and Future Therapies. Ophthalmology Monograph 14. San Francisco: American Academy of Ophthalmology; 2000:49-53, 226.

4. Zechmeister-Koss I, Huic M. Vascular endothelial growth factor inhibitors (anti-VEGF) in the management of diabetic macular oedema: a systematic review. Br J Ophthalmol. 2012 Feb;96(2):167-78.

5. Hong T, Mitchell P, de Loryn T, Rochtchina E, Cugati S, Wang JJ. Development and progression of diabetic retinopathy 12 months after phacoemulsification cataract surgery. Ophthalmology. 2009 Aug;116(8):1510-4

Cataract associated with uveitis

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Chronic or recurrent uveitis
2. Corticosteroids to treat uveitis
3. May progress rapidly to a mature cataract, and generally more rapid than age-related cataract

B. Define the relevant aspects of epidemiology of the disease

1. Rates of cataract formation increase with frequency and duration of uveitis and treatment
2. Cataracts form in up to 70% of patients with Fuchs heterochromic iridocyclitis

C. List the pertinent elements of the history

1. Progressive loss of vision, sometimes rapid
2. Glare, halos
3. Monocular diplopia
4. Vision worse at near than at distance if posterior subcapsular cataract

D. Describe pertinent clinical features

1. Posterior subcapsular cataract
2. May progress to or involve anterior subcapsular cortical fibers
3. May present as cortical cataract without posterior subcapsular component
4. Mature cataract may prevent view of posterior segment
5. Posterior synechiae
6. Pupillary membrane
7. Anterior chamber cell or flare
8. Vitreous cell or haze or snowballs

II. Define the risk factors

A. Autoimmune disorders

1. Behçet Disease
2. Vogt-Koyanagi-Harada
3. Human leukocyte antigen (HLA) B27 and associated diseases
4. Juvenile rheumatoid arthritis (JRA)
5. Fuchs heterochromic iridocyclitis
    a. Some evidence this may be infectious
6. Pars planitis
7. Sarcoidosis

B. Infectious disorders

1. Herpes simplex/zoster
2. Syphilis
3. Toxoplasmosis

4. Tuberculosis

5. Lyme

C. Prolonged corticosteroid use, topical or systemic

III. List the differential diagnosis

A. Phacolytic glaucoma

B. Endogenous endophthalmitis

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Cycloplegic eye drops and ointments

2. Corticosteroids (drops, orals, Sub Tenon and intracameral injections)

3. Multidisciplinary approach to management of systemic immunomodulatory therapy including uveitis specialist and rheumatologist.

B. Describe surgical therapy options

1. Prior to cataract extraction

   a. No preoperative inflammation for at least 3 months

   b. Consider oral corticosteroids 1-week prior

   c. Topical agents in those patients controlled with same

   d. Non steroidal anti-inflammatory eye drops pre-operatively

   e. Homatropine to break posterior synechiae

2. Phacoemulsification

   a. Consider age of patient

      i. Urgent if in amblyogenic age group

      ii. Can often be deferred in middle childhood and teen years until more mature

   b. Use small-incision clear corneal incision rather than large incision extracapsular surgery to preserve conjunctiva for future glaucoma procedures and minimize postoperative synechiae

   c. Synechiolysis with ophthalmic viscosurgical devices (OVD's) and/or spatula or similar instrument

   d. May require hooks or ring to stabilize floppy iris and control pupillary aperture

   e. Capsular dye if required for capsule visualization

   f. Intraocular lens

      i. All efforts made to achieve complete in-the-bag fixation with capsulorrhexis overlap

   g. Consider aphakia in children with JRA

   h. Consider intraoperative IV, periocular injection, or intraocular corticosteroids

3. After cataract extraction

   a. Topical corticosteroid and non-steroidal anti-inflammatory drops

   b. Systemic corticosteroids

   c. Periocular injections

V. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of postoperative inflammation
2. Increased risk of postoperative pressure spike or hypotony
3. Increased risk of cystoid macular edema
4. Increased incidence of weakened zonules
5. Increased risk of capsular phimosis
6. Increased risk of posterior synechiae and peripheral anterior synechiae
7. Increased risk of pupillary membrane or IOL membrane

VI. Describe disease-related complications

A. Glaucoma

B. Chronic uveitis

C. Cystoid macular edema

VII. Describe appropriate patient instructions

A. Inform patient about risks and benefits of cataract surgery

1. Compared to a typical cataract surgery patient, prolonged follow-up, increased need for medications, much higher risk of postoperative inflammatory complications and increased likelihood of additional procedures (injections, imaging, lasers), and may precipitate (or aggravate) pre-existing iridocyclitis

B. Inform patient about risk of untreated uveitis

C. Advise against abrupt cessation of systemic corticosteroid if used chronically

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. Alio JL, Chipont E, BenEzra D, et al. Comparative performance of intraocular lenses in eyes with cataract and uveitis. J Cataract Refract Surg 2002; 28:2096-108.
4. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Perforating and penetrating injury of the lens

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Penetrating injury- disruption of one surface (usually anterior) of the lens
2. Perforating injury- through and through injury of the lens
3. Penetrating injury results in cortical opacification at site
4. Rarely, capsule defect may seal resulting in a focal opacity
5. Usually progresses to complete lens opacification

B. List the pertinent elements of the history

1. Visual loss following penetrating trauma

C. Describe pertinent clinical features

1. Focal cortical cataract
2. White cataract with capsular irregularity/scar
3. Full thickness corneal or corneoscleral scar
4. Anterior or posterior nucleus subluxation
5. High intraocular pressure, anterior chamber cell and conjunctival injection may result from liberated lens particles

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Seidel testing
2. B scan ultrasound
    a. Intact posterior capsule
    b. Presence of intraocular foreign body
3. Computed tomography scan to rule out intraocular foreign body (no magnetic resonance imaging if any chance of metallic foreign body)

II. Define the risk factors

A. Penetrating trauma

1. More common in workplace or in sports or recreational activities where protective eyewear is not worn

III. List the differential diagnosis

A. Anterior polar cataract

B. Posterior subcapsular cataract

C. Cortical cataract

D. Mature cataract

E. Endophthalmitis

IV. Describe patient management in terms of treatment and follow-up

A. Define medical therapy

1. Update tetanus, systemic and topical antibiotics
2. Intraocular inflammation, hemorrhage and pressure should be well controlled prior to surgical intervention.
3. Urgent cataract removal if intraocular pressure cannot be controlled medically and lens-particle glaucoma present

B. Define surgical therapy options

1. Consider primary ruptured globe repair prior to cataract surgery if deemed necessary
2. Phacoemulsification/extracapsular cataract extraction
    a. Capsular staining to identify traumatic tear
    b. No hydrodissection if posterior penetration suspected
    c. Usually can aspirate lens material in younger patients without need for nucleofractis

V. List the complications of treatment, their prevention and management

A. Complications of cataract surgery

1. Increased risk of anterior radial capsular tear
2. Increased risk of vitreous loss
3. Increased risk of lens material in vitreous
4. Increased risk of retinal detachment
5. Increased risk of endophthalmitis

VI. Describe disease-related complications

A. Lens particle glaucoma

B. Traumatic glaucoma

C. Endophthalmitis

VII. Describe appropriate patient instructions

A. Higher risk of complication during cataract surgery

B. Risks of glaucoma and need for regular eye exams in the future

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2001, 2nd edition, p.21.

General anesthesia

I. Describe the technique

A. Indications/contraindications

1. Indications:
    a. Open globe injuries (perforation, penetration, or suspected ruptured globe/globe exploration)
        i. To avoid coughing, squeezing, or Valsalva during intubation or extubation to prevent extrusion of intraocular contents
    b. Claustrophobic patients
    c. Excessive anxiety
    d. Tremor
    e. Chronic coughing
    f. Most teenagers and children
    g. Patients unlikely to cooperate (dementia, intellectual disability, psychiatric disorders)
    h. Spasmodic torticollis
    i. Allergy to injectable and/or topical anesthetic agents
    j. Prolonged procedures
    k. Significant nystagmus
    l. Equatorial staphyloma
2. Contraindications
    a. Personal or family history of adverse reactions to anesthesia
        i. Especially malignant hyperthermia
    b. High risk of anesthesia complication due to systemic disease
        i. Comprehensive pre-operative history and examination is mandatory

B. Techniques used in ophthalmic surgery

1. Premedication and a period of fasting should be prescribed to facilitate sedation and antiemesis
2. Most ocular procedures demand profound analgesia but minimal skeletal muscle relaxation
3. The airway must be protected from obstruction
4. The anesthesiologist, along with the anesthetic apparatus, must be a safe distance from the surgical field

C. Types of general anesthesia

1. Laryngeal mask
    a. Short cases
    b. Minimal or no paralytic needed
    c. No "open globe"
    d. More rapid recovery than endotracheal
2. General endotracheal
    a. Complete paralysis
    b. "Open globes"
    c. Longer cases
    d. Greater nasopharyngeal and laryngeal morbidity (typically short-term)

II. List inherent advantages over local

A. Patient is asleep, eliminating fear and anxiety

B. Patient is immobile

III. List inherent disadvantages compared to local

A. Greater systemic risk with commensurately higher morbidity and mortality

B. Patients with inadequate anesthesia may tend to buck or cough, increasing intraocular pressure

C. Delayed recovery and ambulation

D. Postoperative light-headedness, disorientation, and pharyngitis

E. Some otherwise cognitively intact elderly patients may suffer prolonged or permanent cognitive deficits following general anesthesia

F. Nausea and vomiting

IV. Describe complications of this procedure

A. Non-sight threatening

1. Corneal abrasion
2. Chemical injury
3. Mild visual symptoms

B. Sight threatening

1. Hemorrhagic retinopathy
2. Retinal ischemia
3. Central retinal artery occlusion
4. Posterior ischemic optic neuropathy

C. Life-threatening or organ threatening

1. Adverse reactions to anesthesia
2. Drug interactions
3. Malignant hyperthermia
4. Deep vein thrombosis /pulmonary embolus
5. Hypotension with global hypoperfusion and sequelae

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Focal Points: Sutured Posterior Chamber Intraocular Lenses, Module #9, 2006
3. Chidiac E Raiskin A. Succinylcholine and the Open Eye. Ophthalmol Clin North Am. 2006;19(2):279-85.

Retrobulbar anesthesia

I. Describe the technique

A. Indications/contraindications

1. Indications
    a. Cooperative patients
    b. Need for ocular and orbital akinesia and anesthesia
    c. Consider retrobulbar block in hearing impaired patients or language barrier/inability to follow commands
2. Relative contraindications
    a. Lengthy procedures
    b. Formation of adhesions and fibrous tissue from previous operations may not allow even spread of the local anesthetic, resulting in incomplete blocks.
    c. Head tremor, anxiety and noncooperative patient
    d. Equatorial or posterior staphyloma, prior scleral buckle procedure
    e. Extremely long axial length

B. Alternatives

1. Peribulbar anesthesia
2. Topical anesthesia with/without intracameral anesthesia
3. General anesthesia
4. Sub-Tenon anesthesia

C. Description of instrumentation and technique (many variations exist):

1. Retrobulbar block entails injection of local anesthesia into the muscular cone behind the globe
2. A sharp or blunt 23, 25, or 27-gauge needle, no longer than 31 mm, is introduced through the lower lid in the inferotemporal quadrant at the junction of the lateral and the middle thirds of the lower orbital rim
    a. This can also be performed by pulling down the lower lid and giving the injection through the conjunctiva in the inferior fornix.
3. It's important to maintain the eye in primary position during injection, and direct the needle toward the inferior portion of the superior orbital fissure rather than toward the apex
4. The plunger of the syringe is withdrawn to verify that an unwanted intravascular penetration has not occurred, and 3-4 ml of local anesthetic is then injected
5. The retrobulbar injection may be followed by gentle massage of the globe to enhance dispersion of the local anesthetic, with gentle pressure to tamponade orbital vessels and minimize hemorrhage

D. Monitoring (depends on degree of sedation, if any)

1. Pulse oximetry
2. Electrocardiogram
3. Blood pressure
4. Pulse
5. Ready access for intravenous drug administration should be available
6. Severe systemic complications occur rarely, but may be disastrous without proper preparation
7. Akinesia of the extraocular muscle is tested by observing whether the patient can move the eye in four opposite directions (up, down, right and left)
8. Failure to achieve akinesia within 10 min may necessitate repeating the block or use of an alternative

method

II. Inherent advantages

A. Effective akinesia and analgesia

III. Inherent disadvantages

A. Vision and life threatening complications

B. Pain

C. Elevated intraocular pressure secondary to increased orbital pressure unless anesthetic is allowed to disperse with time and massage

D. Delayed postoperative recovery of vision and extraocular movements

E. Patient needs to be patched after surgery, so will be unable to see until block resolved (relevant for monocular patients)

IV. Complications

A. Non-sight threatening

1. Ecchymosis
2. Ptosis
3. Diplopia
4. Prolonged muscle malfunction
5. Chemosis
6. Periocular discoloration

B. Sight threatening

1. Globe perforation: Risk of retinal detachment and vitreous hemorrhage via inadvertent intraocular injection, or endophthalmitis
2. Central retinal artery occlusion
3. Penetration of optic nerve and posterior optic atrophy
4. Contralateral amaurosis and contralateral extraocular akinesia
5. Ocular myelotoxic effects of local anesthetics
6. Retrobulbar hemorrhage - higher risk in anti-coagulated patient

C. Life-threatening

1. Stimulation of oculocardiac reflex arc
2. Intra-arterial injection, producing immediate cardiac arrhythmias
3. Inadvertent intradural injection associated with seizures, respiratory arrest
4. Brain stem anesthesia

D. Prevention and management of complications

1. Use appropriate needles
2. Maintenance of primary gaze of the eye during injection
3. Direct needle away from the globe
4. Check for intravascular needle penetration prior to injection
5. Prompt identification of retrobulbar hemorrhage with surgical decompression (lateral canthotomy and cantholysis) if necessary

6. Immediately available cardiopulmonary support

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, p. 33, 51-52.
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4. Fanning GL. Orbital regional anesthesia. Ophthalmol Clin North Am 2006; 19(2): 221-32.
5. Khoo BK, Lim TH, Yong V. Sub-Tenon's versus retrobulbar anesthesia for cataract surgery. Ophthalmic Surg Lasers 1996;27:773-7.
6. Patel BC, Burns TA, Crandall A, et al. A comparison of topical and retrobulbar anesthesia for cataract surgery. Ophthalmology 1996;103:1196-203.
7. Huber KK, Remky A. Effect of retrobulbar versus subconjunctival anaesthesia on retrobulbar haemodynamics. Br J Ophthalmol 2005;89:719-23.

Peribulbar anesthesia

I. Describe the technique

A. Indications and contraindications

1. Indications
    a. Cooperative patients
    b. Long axial length
2. Relative contraindications
    a. Formation of adhesions and fibrous tissue caused by earlier surgeries in the eye may not allow even spread of the local anesthetic, resulting in incomplete blocks
    b. Head tremor, anxiety and noncooperative patient
    c. Equatorial staphyloma

B. Alternatives

1. Retrobulbar anesthesia
2. Topical anesthesia with/without intracameral anesthesia
3. General anesthesia
4. Sub-Tenon anesthesia

C. Description of instrumentation and technique (variations exist)

1. Peribulbar block entails injection of local anesthetic external to the muscular cone in the orbit
2. Possible injection sites include: inferotemporal, superior, superonasal, and the medial canthus. Two injections are sometimes required at separate sites to achieve full effect
    a. For all sites the needle is held in a plane parallel to the orbital axis, careful aspiration is performed, and approximately 4-5 ml or less of anesthetic solution is injected in each site with a short needle

D. Monitoring (depends on degree of sedation, if any)

1. Pulse oximetry
2. Electrocardiogram
3. Blood pressure
4. Pulse
5. Ready access for IV drug administration should be available
6. Severe systemic complications occur rarely, but may be disastrous without proper preparation
7. Akinesia of the extraocular muscle is tested by observing whether the patient can move the eye in four opposite directions (up, down, right and left)
    a. Block may be repeated or alternate modality employed

II. Inherent advantages compared to other anesthetic options

A. Effective akinesia and analgesia (compared to topical)

B. Rapid postoperative recovery of vision (compared to retrobulbar)

C. Reduced risk of ocular/peribulbar complications (compared to retrobulbar)

III. Inherent disadvantages

A. Onset is usually slower than retrobulbar technique

B. Increased pressure on the globe consequent to the larger volume of local anesthetic deposited in the orbit

C. Less likely for complete akinesia of globe compared to retrobulbar block

IV. Complications

A. Non-sight threatening

1. Ptosis
2. Diplopia
3. Prolonged muscle malfunction
4. Chemosis
5. Postoperative ecchymosis

B. Sight threatening

1. Optic nerve or retinal ischemia due to mechanical effect of greater volume injection
2. Rare perforations of the globe
3. Ocular myotoxic effects of local anesthetics

C. Life-threatening

1. Stimulation of oculocardiac reflex

D. Prevention and management of complications

1. Use appropriate needles
2. Maintenance of primary gaze of the eye during injection
3. Direct needle away from the globe

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 33, 51-52.
3. Sauder G, Jonas JB. Topical versus peribulbar anesthesia for cataract surgery. Acta Ophthalmol Scand 2003; 81: 596-9.
4. Heuermann T, Hartmann C, Anders N. Long-term endothelial cell loss after phacoemulsification: peribulbar anesthesia versus intracameral lidocaine 1%: prospective randomized clinical trial. J Cataract Refract Surg 2002;28:639-43.
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6. Watkins R, Beigi B, Yates M, et al. Intraocular pressure and pulsatile ocular blood flow after retrobulbar and peribulbar anaesthesia. Br J Ophthalmol 2001;85:796-8.
7. Ripart J, Lefrant JY, Vivien B, et al. Ophthalmic regional anesthesia: medial canthus episcleral (sub-Tenon) anesthesia is more efficient than peribulbar anesthesia: A double-blind randomized study. Anesthesiology 2000;92:1278-85.
8. Lung S, Luksch A, Weigert G, et al. Influence of infusion volume on the ocular hemodynamic effects of peribulbar anesthesia. J Cataract Refract Surg 2006;32:1509-12.

Sub-Tenon anesthesia

I. Describe the technique

A. Indications/contraindications

1. Indications
    a. Alert and cooperative patients
    b. Long axial length
2. Relative contraindications
    a. Lengthy procedures (relative - may repeat)
    b. Formation of adhesions and fibrous tissue from previous operations that may not allow even spread of the local anesthetic, resulting in incomplete blocks
    c. Head tremor, anxiety and noncooperative patient

B. Description of instrumentation and technique

1. Sub-Tenon infusion of anesthetic via a curved cannula
2. Topical anesthetic is applied
3. A small incision is made through the conjunctiva and Tenon capsule. Care should be taken to avoid the insertions of the extraocular muscles
4. A curved cannula is passed through the openings posterior to the equator along the globe
5. Two to five ml of anesthetic solution is injected (mixture may vary)
6. Anesthesia usually occurs within 1-3 minutes
7. Akinesia may require 5 min to develop

C. Monitoring (depends on degree of sedation, if any)

1. Pulse oximetry
2. Electrocardiogram
3. Blood pressure
4. Pulse
5. Ready access for intravenous drug administration should be available
6. Severe systemic complications occur rarely, but may be disastrous without proper preparation

II. Inherent advantages

A. Less painful than peribulbar or retrobulbar anesthesia

B. Rapid postoperative recovery

C. Immediate anesthesia

D. Safety

1. Greatly eliminates risks of
    a. Globe penetration
    b. Retrobulbar hemorrhage
    c. Optic nerve trauma

E. No postoperative ecchymosis

III. Inherent disadvantages

A. Technical difficulties

B. Complete akinesia is sometimes difficult to attain

IV. Complications

A. Non-sight threatening

1. Chemosis
2. Subconjunctival hematoma/hemorrhage
3. Rectus muscle trauma

B. Sight-threatening

1. Diplopia due to muscular trauma

C. Life threatening

1. None reported

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 9: Intraocular Inflammation and Uveitis, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 33.
3. Matthew MR, Williams A, Esakowitz L, et al. Patient comfort during clear corneal phacoemulsification with sub-Tenon's local anesthesia. J Cataract Refract Surg 2003;29:1132-6.
4. Ramsay AS, Ray-Chaudhuri N, Dayan M, et al. Quantification of relative afferent pupillary defects induced by posterior sub Tenon's, peribulbar, and retrobulbar anaesthetics. Br J Ophthalmol 2001;85:1445-6.
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6. Ripart J, Lefrant JY, Vivien B, et al. Ophthalmic regional anesthesia: medial canthus episcleral (sub-tenon) anesthesia is more efficient than peribulbar anesthesia: a double-blind randomized study. Anesthesiology 2000;92:1278-85.
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8. Dorey SE, Seward HC, de Alwis D. A randomised trial of topical versus sub-Tenon's local anaesthesia for small incision cataract surgery. Eye 1997;11:435-6.
9. Ruschen H, Celaschi D, Bunce C, et al. Randomised controlled trial of sub-Tenon's block versus topical anaesthesia for cataract surgery: a comparison of patient satisfaction. Br J Ophthalmol 2005;89:291-3.

Topical/intracameral anesthesia

I. Describe the technique

A. Indications/contraindications

1. Indications
    a. Alert, cooperative, communicative patients who can follow instructions
    b. Shorter procedures
2. Contraindications
    a. Lengthy cases (though repeat application of topical anesthetic may prove adequate)
    b. Complex procedures with significant tissue manipulation
    c. Anxious or claustrophobic patients
    d. Patients who are unable to communicate or cooperate
    e. Patients with a language barrier
    f. Severe or large amplitude nystagmus
    g. Anesthetic allergy
    h. Procedures which require a wound with a non-contained system (i.e. open globe, penetrating keratoplasty)

B. Alternatives

1. Retrobulbar anesthesia
2. Peribulbar anesthesia
3. General anesthesia
4. Sub-Tenon anesthesia

C. Description of instrumentation and technique

1. Pre-operative assessment of the patient's anxiety level to determine whether the patient is a candidate for topical anesthesia and whether supplemental intravenous (IV) sedation will be necessary
2. Topical anesthesia is administered
3. Multiple applications over several minutes may be required
4. As an optional adjunct to topical anesthesia, intracameral anesthesia may be used: inject approximately 0.1 to 0.5 ml of nonpreserved 1% lidocaine into the anterior chamber
    a. Nonpreserved lidocaine 1% can be made using nonpreserved lidocaine 4% diluted with balance saline solution to ensure physiologic pH
        i. Manufactured lidocaine 1% can have a non-physiologic pH causing anterior segment toxicity or toxic anterior segment syndrome (TASS)
5. Patient is instructed to look only at the light of the microscope
6. The patient is advised as to what sensations they might expect during the procedure
7. Continual communication and reassurance assists in reducing patient anxiety
8. Conversion to alternate technique of anesthesia if poor fixation, poor cooperation, anxiety, or other failure in safe progression of procedure

D. Monitoring

1. Pulse oximetry
2. Electrocardiogram
3. Blood pressure

4. Pulse

II. List inherent advantages compared to general anesthesia or orbital block

A. More rapid recovery of vision than orbital block

B. Reduced potential for systemic effects, globe perforation/ocular complications from anesthetic injection such as diplopia or retrobulbar hemorrhage

C. Can add preservative-free bisulfite-free epinephrine to Intracameral lidocaine at 0.025% dilution to enhance dilation of iris

D. Gaze cooperation from patient

E. Less trauma to periocular structures

III. List inherent disadvantages compared to general anesthesia or orbital block

A. Greater likelihood of patient sensation during surgery

B. Unwanted eye movement during surgery from lack of akinesia

C. Unexpected eye or head movement during surgery due to patient sensation

D. Other means of anesthetic administration may be required if patient is unable to cooperate or unforeseen complications of surgery develop

E. Possible dilutional/labeling errors with endothelial toxicity in solutions introduced into the anterior chamber

IV. Describe complications associated with this procedure

A. Non-sight threatening

1. Transient amaurosis

B. Sight-threatening

1. If agents with preservative are inadvertently used in the anterior chamber, corneal decompensation may result

V. Prevention and management of complications

A. Use preservative-free solutions in appropriate concentrations

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 32.
3. Ophthalmic Technology Assessment: Intracameral Anesthesia, Ophthalmic Technology Assessment Committee Anterior Segment Panel, American Academy of Ophthalmology, *Ophthalmology,* 2001; 108:1704-10.
4. Boulton JE, Lopatatzidis A, Luck J, et al. A randomized controlled trial of intracameral lidocaine during phacoemulsification under topical anesthesia. Ophthalmology. 2000;107:68-71.
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7. Tseng SH, Chen FK. A randomized clinical trial of combined topical-intracameral anesthesia in cataract surgery. Ophthalmology. 1998;105:2015-2016.

Infection prophylaxis

I. Purpose is to prevent post-operative infections

A. Types of infections

1. Endophthalmitis
    a. Rates after phacoemulsification
        i. Reported from 0.08% to 0.68%
    b. Risk factors
        i. Pre-operative ocular surface infection
        ii. Altered host flora
        iii. Contact lens use
        iv. Immune system compromise from drugs or disease
        v. Vitreous loss during surgery
        vi. Poorly constructed incisions which may leak
    c. Complications of endophthalmitis
        i. Retinal detachment/atrophy/scarring
        ii. Retinal vascular occlusion
        iii. Optic neuropathy
        iv. Corneal decompensation
        v. Anterior segment fibrosis
        vi. Epiretinal membrane
        vii. Macular edema
        viii. Phthisis
    d. Treatment of endophthalmitis
        i. Choice of initial procedure is guided by the presenting visual acuity:
            i) For eyes with vision of light perception, pars plana vitrectomy and intraocular injection of antibiotics
            ii) For eyes with better than light perception, injection of intraocular antibiotics after tap for anterior chamber or vitreous culture
                (i) Vancomycin and ceftazidime, most common
                (ii) Systemic, topical, and peri-ocular antibiotics not as effective, but can be considered
2. Keratitis at incision site rare

B. Microorganisms - patient's own skin/ocular flora source of most infections

1. Gram positive bacteria cause vast majority of infections
        i. Coagulase-negative Staphylococcus
    b. Staphylococcus aureus
    c. Streptococcus species
    d. Enterococcus species
2. Gram negative and fungi more uncommon
    a. Often cause more severe infections

3. Late onset indolent endophthalmitis may be caused by Propionibacterium acnes

II. Technique

A. Pre-procedure evaluation

1. Ocular conditions that increase risk of infection
    a. Treat pre-existing blepharitis, dacryocystitis, conjunctivitis
2. Systemic conditions
    a. Optimize treatment for diabetes, HIV, rheumatoid conditions

B. Peri-operative antibiotic drops

1. Evidence for efficacy is weak
2. Often used pre-operatively - immediate versus 24-72 hours
3. Postoperative use common for days to weeks
4. Fluoroquinolones, aminoglycosides most common

C. Immediate pre-operative sanitization of ocular surface

1. 5% povidone iodine drops immediate pre-op decreases bacteria load on eye surface and significantly reduces risk

D. Intracameral antibiotics

1. ESCRS study and others have shown efficacy of cefuroxime injection at end of surgery
2. Moxifloxacin injection at end of surgery increasing in use
3. Antibiotics in infusion solution are not recommended and actively discouraged

E. Peri-ocular antibiotic injections

1. Questionable efficacy and increased risk over topicals

F. Systemic antibiotics

1. Role in infection prophylaxis for cataract surgery not established
2. Fluoroquinolones thought to penetrate vitreous cavity best
    a. May be used in treatment of endophthalmitis
    b. May be used in cataract surgery if associated with recent trauma

III. Complications

A. Drug allergies

1. Antibiotics
2. Iodine

B. Labeling/ medication choice/dilutional errors for intraocular injections

1. Toxic substances
    a. Preservatives
2. Certain anti-infective agents
    a. Gentamicin may cause retinal toxicity and macular infarction
        i. Amphotericin B may cause retinal toxicity
3. High concentrations may be dangerous
    a. Vancomycin can cause cystoid macular edema

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Maguire J. Postoperative endophthalmitis:optimal management and the role and timing of vitrectomy surgery. Eye (2008) 22, 1290-1300.

3. Endophthalmitis Vitrectomy Study Group. Results of Endophthalmitis Vitrectomy Study. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol 1995; 113: 1479-1496.

4. Cooper BA, Holekamp NM, Bohigian G, et al. Case-control study of endophthalmitis after cataract surgery comparing scleral tunnel and clear corneal wounds. Am J Ophthalmol 2003; 136: 300-305.

5. Barry P, Seal DV, Gettinby G, et al. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: preliminary report of principal results from a European multicenter study. J Cataract Refract Surg 2006; 32: 407-410.

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8. Lundstrom M, Wejde G, Stenevi U, et al. Endophthalmitis after cataract surgery: a nationwide prospective study evaluating incidence in relation to incision type and location. Ophthalmology 2007;114:866-70.

Ophthalmic viscosurgical devices

I. Ophthalmic viscosurgical devices (OVDs) rheologic and physical properties

A. Elasticity

1. Tendency of an object to go back to its original size and form after being stretched, compressed, and deformed
2. Maintains shape/ space

B. Viscosity

1. Measure of the resistance of a solution to a flow
2. Depends on the degree of movement within the solution (shear rate)
3. At rest (zero shear rate), viscosity depends on the OVD component concentration, molecular weight, and size of the flexible molecules or coils

C. Pseudoplasticity

1. Ability of the solution to transform under pressure from a gel to a more liquid substance
2. Pseudoplastic solutions have a low viscosity at high shear rates

D. Cohesiveness/dispersiveness

1. Cohesive OVDs
    a. The material tends to adhere to itself, not ocular tissue
    b. Generally, have high molecular weight, high surface tension and high pseudoplasticity
    c. Are able to maintain space or remain in place, and displace and stabilize tissues until subjected to turbulence from high flow of fluid through the chamber (high shear)
    d. Tend to be easily aspirated and rapidly removed from the eye
    e. Tend to flow out of the eye during phacoemulsification
    f. May block the trabecular meshwork and cause the intraocular pressure (IOP) to rise
2. Dispersive OVDs
    a. Tend to adhere to the surface of the tissue, instrument or the implant
    b. Little tendency for self-adherence, thus, is more likely to fracture than to aspirate in one bolus
    c. Low molecular weight, low surface tension
    d. Tend to remain in the eye adjacent to the corneal endothelium, giving potential protection during phacoemulsification
    e. Can be used to move and isolate intraocular tissues
    f. Poorly effective in maintaining space and sometimes difficult to remove
    g. Reduced tendency for IOP elevation when compared with cohesive OVDs
3. Other categories proposed
    a. Viscoadaptive and viscous dispersive used for OVDs with properties that overlap categories

II. Functions during surgery

A. Create and maintain space in the anterior segment

1. Flatten anterior capsule and maintain anterior chamber during capsulorrhexis
2. Inflating capsular bag prior to intraocular lens or capsular tension ring implantation

B. Protect cells and tissues during surgery

C. Manipulation of tissues

1. Moving iris (repositing prolapsed iris, creating space in sulcus for instruments such as iris hooks/rings)
2. Separating anterior or posterior synechiae
3. Viscomydriasis
4. Sequestering vitreous in posterior segment in cases of capsular or zonular disruption
5. Viscodissection of capsule during IOL exchange
6. Maintenance of capsule contour in cases of zonule laxity

D. Lubrication of tissues, instruments and implants: protecting inadvertent injury by intraocular instrumentation

III. Complications

A. IOP increase

1. Due to incomplete removal of OVD (retained in anterior chamber or in sclerostomy in post-trabeculectomy patients)
    a. Severe/prolonged IOP elevation is more likely to be caused by retained cohesive viscoelastic, however, dispersive viscoelastic can be more difficult to remove from the eye, and can also cause a severe IOP spike
    b. Removal of the OVD from the anterior segment as completely as possible is recommended
2. Related to high molecular weight, high viscosity, and increased chain length of molecule
3. Treatment for elevated IOP
    a. Known or suspected retention of OVD
        i. Instillation of long-acting intraocular miotics
        ii. Topical application of glaucoma medication
        iii. Short term oral carbonic anhydrase inhibitors
    b. Elevated IOP post-operatively
        i. Topical application of glaucoma medication
        ii. Short term oral carbonic anhydrase inhibitors
        iii. Release of fluid/OVD at slit lamp ("Burping" the paracentesis)
        iv. Anterior chamber washout

B. Incision burn

1. Prevented by partial aspiration of OVD prior to application of ultrasound energy

C. Rare postoperative reactions including inflammation (e.g., iritis), corneal edema, corneal decompensation, or capsular bag distension syndrome

IV. OVD substances

A. Sodium hyaluronate

1. Cohesive in general
2. Comes in many different formulations with different properties
3. Advantages:
    a. Create and maintain space
    b. Easy insertion and removal
    c. Clarity
4. Disadvantages:

a. IOP increase after surgery unless agent is fully removed

b. Poor coating capability

c. Necessity to be refrigerated

B. Hydroxypropyl methylcellulose (HPMC)

1. Dispersive
2. Advantages
   a. Low cost
   b. Does not require refrigeration
3. Disadvantages
   a. More difficult to remove from anterior chamber
   b. Does not maintain space well

C. Chondroitin sulfate

1. Available only in combination with sodium hyaluronate
2. Combinations are dispersive or viscous dispersive
3. Advantages
   a. Coats tissues and instruments well
   b. Good retention in eye during surgery
4. Disadvantages
   a. Particulate material may become suspended during phaco
   b. Maintains spaces less well

Additional Resources

1. Arshinoff SA, Albiania DA, Taylor-Laporte J. Intraocular pressure after bilateral cataract surgery using Healon, Healon5, and Healon GV. J Cataract Refract Surg 2002;28:617-25.
2. Maar N, Graebe A, Schild G, et al. Influence of viscoelastic substances used in cataract surgery on corneal metabolism and endothelial morphology: comparison of Healon and Viscoat. J Cataract Refract Surg 2001;27:1756-61.
3. Bissen-Miyajima H. Ophthalmic viscosurgical devices. Curr Opin Ophthalmol. 2008;19(1):50-4.
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5. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
6. Goldman JM, Karp CL. Adjunct devices for managing challenging cases in cataract surgery: capsular staining and ophthalmic viscosurgical devices. Curr Opin Ophthalmol 2007;18:52-7. Review.
7. Vajpayee RB, Verma K, Sinha R, et al. Comparative evaluation of efficacy and safety of ophthalmic viscosurgical devices in phacoemulsification [ISRCTN34957881]. BMC Ophthalmol 2005;5:17.

Incision construction

Small Incisions: Clear-cornea, limbal and scleral tunnel incisions

I. Indications

A. Used for phacoemulsification and foldable intraocular lens (IOL) insertion

B. Most common due to speed, sturdier wound construction, less surgical trauma

II. Advantages

A. Better fluidic seal around phacoemulsification tip

B. May be self-sealing

C. Safer in emergency - suprachoroidal hemorrhage, patient cooperation, etc

D. Less surgical trauma

E. Decreases suture-induced astigmatism

F. Faster than larger incisions

G. Preserves conjunctiva for blebs if needed

III. Disadvantages

A. Requires nucleus disassembly prior to removal

B. May be associated with wound burn/corneal endothelial injury with dense cataracts

IV. Wound Location

A. Incision can begin in clear cornea, at limbus or within sclera

1. Clear cornea incision starts inside limbus and avoids most blood vessels
2. Limbal incision begins at blue line or limbus; may intersect corneal pannus and limbal vessels
3. Scleral tunnel starts 1-2 mm behind limbus after exposure via conjunctival peritomy

B. Incision orientation

1. Temporal location may have
    a. Better visualization and red reflex
    b. Enhanced fluid drainage from ocular surface with head tilt
    c. Reduced against-the-rule astigmatism and less induced astigmatism compared to superior location
    d. Temporal location is furthest from visual axis
2. Superior location may have
    a. Less risk of endophthalmitis
    b. Less trauma to corneal innervation

V. Technique

A. General principles

1. "Square incision" concept: self-sealing ability improves with longer radial length and shorter circumferential width

2. For phacoemulsification, smaller width permits incision to be located superiorly, temporally, or obliquely. Long-term, an incision tends to flatten the meridian it is placed on (e.g., a superior incision flattens the 90-degree meridian over time, leading to against-the-rule shift in astigmatism based on the length of the incision)

3. Variations in initial groove geometry, width and lamellar dissection can allow for planned conversion to manual ECCE and rigid intraocular lens (IOL) insertion

B. Clear cornea and limbal

1. Multiplanar incision with diamond blade, metal blade or laser

2. Groove optional

C. Scleral tunnel

1. Conjunctival peritomy exposes bare sclera 1-2 mm posterior to limbus

2. Cautery may be used to control bleeding

3. Special blade used to make partial thickness lamellar dissection into clear cornea

4. Keratome enters through Descemet's membrane; entry point is visualized by depressing the keratome tip down just prior to entry. This creates a multi-plane incision

D. Large scleral tunnel for manual small incision cataract surgery (MSICS)

1. Large conjunctival peritomy

2. Cautery may be used to control bleeding

3. Crescent blade used to make 5-8 mm 50% thickness "frown incision" (arc shaped incision) with the base of the curve 1-2 mm posterior to the limbus. The crescent blade is then used to create a partial thickness funnel shaped lamellar dissection into clear cornea

4. Keratome enters through Descemet membrane; entry point is visualized by depressing the keratome tip down just prior to entry. The keratome is used to create a large interior wound opening (approximately 10-11 mm)

VI. Complications

A. Too posterior

1. Premature entry - bleeding, not self-sealing

2. Iris prolapse

B. Too short

C. Too anterior

1. Intraoperative corneal striae - compromised visibility and greater endothelial cell loss

D. Too wide

1. Poor fluidic seal, chamber stability, post-operative wound leak

E. Too narrow/tight

1. Increased wound burn and endothelial cell loss due to heat transfer from phaco tip

2. Increased risk of Descemet's tear

3. Increased corneal striae/decreased instrument maneuverability

F. Too thin

1. Roof may tear with excessive manipulation

VII. Clear cornea versus scleral tunnel

A. Clear cornea advantages

1. Generally, faster
2. Topical anesthesia usually sufficient
3. Avoids conjunctival bleeding and manipulation
    a. Cosmetic advantages
    b. Preserves conjunctiva for existing and future blebs

B. Sclera tunnel advantages

1. May be sturdiest incision in case of post-operative trauma
2. May have decreased risk for post-operative endophthalmitis
3. Less distortion of view especially superiorly
4. Less energy delivered to cornea and lower risk of wound burn (advantageous with dense cataracts)
5. If sutures needed, they are located further from central cornea (less astigmatism)
6. More forgiving of larger wounds or imperfect incision construction/architecture/suturing
7. Easier to convert to large incision/manual ECCE

Large peri-limbal incisions

I. Indications

A. Becoming less common as phacoemulsification technology improves

B. May be appropriate when incision needs to be large, such as for extracapsular cataract extraction (manual ECCE), intracapsular cataract extraction (ICCE), and/or planned rigid intraocular lens (IOL) insertion

II. Advantages

A. Permits removal of cataract in single piece or larger fragments if needed (i.e. capsular rupture or extremely dense cataract)

B. Provides large opening for rigid intraocular lens insertion

C. Easy to visualize posterior lip (e.g. during anterior chamber intraocular lens (AC IOL) implantation)

D. Improved access for additional procedures such as iris reconstruction

E. Easy to enlarge and extend if needed

III. Disadvantages

A. Time-consuming

B. Not self-sealing and must be sutured

C. Topical anesthesia rarely appropriate

D. More astigmatism and less forgiving of imperfect suture tension and placement

E. Greater risk of intraoperative suprachoroidal hemorrhage

F. Greater risk of rupture with post-operative blunt trauma

IV. Technique

A. Incision is generally placed superiorly so that it is covered by upper lid. This location provides greater protection of the incision.

B. Conjunctival peritomy and cautery to exposed limbal vessels

C. Aim for surgical limbus - grey white junction: "blue line"

D. Groove - partial thickness perpendicular to sclera, made with a curved blade such as crescent blade. This serves as a guide for scissors; gives a 2-plane incision

E. Beveled entry with keratome and enlargement with scissors or blade - goals are to create shelved incision of adequate size and consistent incision architecture, while avoiding iris trauma

F. Suturing principles

1. Suture - should be non-absorbable (10-0 Nylon common)
2. Interrupted vs. running
    a. Running suture saves operative time, and lessens early suture-induced astigmatism by avoiding a single, disproportionately tight, interrupted suture. However, suture tension declines much earlier, which tends to exacerbate against-the-incision astigmatism drift
    b. Radial sutures take longer to place, and induce greater degree of early post-operative astigmatism if placement, depth, orientation, and tension are not optimal. Tensile strength is maintained longer and will better resist against-the-incision astigmatism drift. They allow for selective removal for astigmatism manipulation

G. Radial orientation - provides best re-approximation of tissue

H. Short, deep bites - gives good tissue apposition with less induced astigmatism

I. Suture tension

1. Long-term, an incision tends to flatten the meridian on which it is placed (e.g., a superior incision flattens the 90-degree meridian over time, leading to against-the-rule shift in astigmatism)
2. Too tight causes excessive early post-operative astigmatism with steepest plus meridian toward suture
3. Too loose can cause incision leaking, gaping and iris prolapse, as well as a greater degree of progressive astigmatic shift (against-the-rule with superior incision) over time (ref 5)

J. When to cut sutures - if too soon, can cause incision gape and against-the-incision astigmatism; Consider cutting tight sutures first then re-assessing in several weeks. Usually generally safe to begin cutting interrupted sutures after 6-8 weeks

V. Complications

A. Incision leak, iris prolapse, incision gape- more likely if improperly constructed and sutured

B. Large amplitude astigmatism - both suture-induced, and late astigmatism due to tissue stretch

C. Exposed suture knots can cause chronic irritation, giant papillary conjunctivitis, suture abscess

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, p.33-36, 49, 52-53.
3. Nichamin LD, Chang DF, Johnson SH, and the American Society of Cataract and Refractive Surgery Cataract Clinical Committee. ASCRS White Paper: What is the association between clear corneal cataract incisions and postoperative endophthalmitis? J Cataract Refract Surg 2006;32:1556-9.
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5. Endophthalmitis Study Group, European Society of Cataract & Refractive Surgeons. Prophylaxis of postoperative endophthalmitis following cataract surgery: results of the ESCRS multicenter study and identification of risk factors. J Cataract Refract Surg. 2007 Jun;33(6):978-88.

Astigmatic keratotomy

I. List the indications/contraindications

A. Indications

1. Reduction of corneal astigmatism
2. Can be performed at the same time as cataract surgery, or post cataract surgery as a secondary procedure
3. Elective, as the benefit is purely refractive

B. Relative contraindications

1. Corneal pathology affecting the desired location of the incision (e.g., pterygium, marginal degeneration, keratoconus, severe autoimmune diseases that predispose to corneal melts)
2. Higher amounts of astigmatism may not be completely corrected:
    a. 1.5D of cylinder or greater may be better treated with toric intraocular lenses (IOLs)
3. Patients at higher risk of future blunt trauma

II. Describe the pre-procedure evaluation

A. Keratometry/ corneal topography

B. Assessment of corneal abnormalities

C. Pachymetry

D. Determination of refractive goal

1. Must consider patient's prior refractive error and goals
2. Must consider refractive error in opposite eye

III. List the alternatives to this procedure

A. Toric IOLs

B. Subsequent refractive surgery

C. Steep meridian placement of cataract incision

D. Spectacle or contact lens correction

IV. Describe the instrumentation and technique

A. Instruments

1. Incisional keratotomy blade - adjustable or fixed depth, or femtosecond laser
2. Axis marking system - gauge and marking pen
3. Fixation device such as fixation ring

B. Nomogram and patient data used to formulate surgical plan

C. Pachymetry should be performed to prevent perforation (thin measurements) and undercorrection (thick measurements)

D. Marking of a reference point while patient sitting up to determine the axis

1. Torsional rotation while supine is a potential problem
2. Following regional block, determination of the reference axis is difficult

E. Placement

1. Peripheral corneal (limbal) relaxing incisions are arcuate incisions that are typically placed in clear cornea just anterior to the limbus
2. Astigmatic keratotomy incisions are placed more centrally

F. Surgical variables - the refractive effect of the incisional astigmatic keratotomy increases with

1. Increasing patient age
2. Increasing incision number and length
3. Increasing incision depth
4. Decreasing optical zone size (e.g., with more centrally located incisions)
5. Prior corneal surgery, e.g., radial keratotomy

V. List the complications of this procedure

A. Unexpected refractive error

1. Over-correction with flipped axis may induce asthenopia

B. Undercorrection or loss of effect

C. Delay to refractive stability

D. Perforation

1. May require a suture to seal
2. Could damage intraocular structures

E. Incorrect placement of incisions

F. Wrong axis may worsen astigmatism

G. Corneal abrasion

1. Generally, not serious

H. Incision gape

1. Technique related
2. Decreased corneal sensation/innervation
3. Avoided with incision < 90 degrees in arc

I. Incision infiltrate/melt

1. Associated with underlying corneal pathology
2. Systemic disorders such as autoimmune or rheumatoid disease

J. Infection - rare

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 68-75.
3. Titiyal JS, Khatik M, Sharma N, et al. Toric intraocular lens implantation versus astigmatic keratotomy to correct astigmatism during phacoemulsification. J Cataract Refract Surg. 2014 May;40(5):741-7.

Extracapsular cataract extraction

I. List the indications/contraindications

A. Indications

1. Excessive patient risk with phacoemulsification e.g., weak zonules, shallow anterior chamber, brunescent lens, corneal endothelial dystrophy
2. Conversion to large incision extracapsular cataract extraction (ECCE) may be indicated if sizable nuclear fragment is present following posterior capture rupture +/- vitreous loss
3. Lack of instruments, training, or infrastructure for phacoemulsification, etc. (e.g., developing world)

B. Contraindications = relative (significant disadvantages compared to phacoemulsification)

1. Combined trabeculectomy or presence of a prior bleb
2. Increased potential of suprachoroidal hemorrhage or of poor patient cooperation
3. Scleral thinning disorders
4. Patients at higher risk for future blunt trauma

II. Describe the instrumentation, anesthesia, and technique

A. Anesthesia

1. Regional injection
    a. Peribulbar
    b. Retrobulbar
    c. Subtenon
2. General anesthesia under special circumstances (See General anesthesia)

B. Instrumentation

1. Lens fragmentation (phacoemulsification, etc.) machine not required
2. Option for manual or automated irrigation/aspiration (I/A) equipment

C. Technique

1. Conjunctival peritomy, scleral cautery
2. Incision construction
    a. Typically placed superiorly (See Incision construction (limbal, scleral pocket, clear corneal)), may also be placed temporally
3. Capsulotomy
    a. Can opener useful as small diameter continuous curvilinear capsulorrhexis (CCC) may impede nucleus delivery
    b. Capsulorrhexis is an option, but must be of adequate diameter relative to nuclear size or make relaxing capsular incisions
4. Nucleus extraction
    a. Bimanual expression
    b. Vectus or lens loop extraction
5. Partial incision closure to allow chamber maintenance for I/A
6. Cortex removal
7. Intraocular lens (IOL) placement

8. Viscoelastic removal
9. Incision closure/suturing (See Incision construction (limbal, scleral pocket, clear corneal))
10. Conjunctival closure
11. Subconjunctival antibiotics and steroids optional
12. Protective shield

III. List advantages compared to phacoemulsification

A. Less equipment needed; potential for decreased intraoperative costs

B. Eliminate risk of incision burn

C. Reduced risk of certain complications

1. Endothelial trauma from excessive ultrasound time
2. Tissue trauma (from phacoemulsification tip)

IV. List disadvantages compared to phacoemulsification

A. Larger incision

1. Less control of anterior chamber stability and depth
2. Not self-sealing in case of intraoperative emergency (choroidal effusion/hemorrhage)
3. Less forgiving of intraoperative external pressure (Valsalva, coughing, lid squeezing, speculum pressure, etc.)
4. Conjunctival trauma
    a. Disadvantage if bleb present or combined procedure needed
    b. Less virgin conjunctiva available for future trabeculectomy
    c. Cosmetic considerations
5. Not appropriate for topical anesthesia
6. Increased iris trauma leading to increased likelihood of intraoperative miosis or postoperative iris deformity
7. Increased suture and incision-induced astigmatism - both early and late postoperatively
8. Increased risk of incision-related complications (early and late)
9. Need for greater physical restrictions postoperatively
10. Prolonged refractive instability
11. Long term refractive instability (against-the-incision astigmatism drift)
12. Suture removal may be necessary

B. Nucleus is not usually fragmented

1. Requires larger capsulorrhexis
    a. Often too large to overlap the optic x 360 degrees
    b. Small diameter CCC may impede nucleus delivery
2. More difficult with smaller pupils

V. Describe general complications

A. Compared to phacoemulsification, main difference in complications is greater incidence of incision-related complications

VI. Describe follow up care and instructions (differences compared to phacoemulsification)

A. Globe protection

1. Protective shield required longer

B. Initial physical restrictions - avoid external pressure

1. Avoid Valsalva and dependent head position
2. Avoid eye rubbing

C. Suture-induced astigmatism

1. Impairs early uncorrected vision
2. Tight sutures may need to be cut
3. Refractive stability and final refraction delayed
4. Increased postoperative visits (because of 2 and 3 above)

D. Long-term incision-induced refractive instability

1. Longer term against-the-incision drift in astigmatism with large, superior incision
2. More frequent changes in refraction for several years

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Riaz Y, Mehta JS, Wormald R, et al. Surgical interventions for age-related cataract. Cochrane Database Syst Rev 2006;CD001323. Review.
3. AAO, Focal Points: Strategies for Complicated Lens Surgery, Module #8, 2005.

Ultrasound - clinical principles

I. Nuclear emulsification - mechanism

A. Ultrasound - principles

1. Metal phaco tip vibrates at high frequency
2. Motion can be longitudinal, torsional, elliptical or a combination
3. Vibration produces mechanical and cavitational effects at tip which
    a. Break apart lens tissue
    b. Create a repelling force
4. Ultrasound energy can be detrimental to adjacent ocular tissue (e.g., endothelium) as tip vibration can induce turbulence and frictional heat
    a. Newer units
        i. More efficient lens emulsification uses less energy in most cases
        ii. Better fluidics leading to improved followability

B. Clinical understanding of phacoemulsification "power"

1. Surgeon uses foot pedal (position 3) to activate ultrasound "power" at phaco tip
2. Machines can be programmed to surgeon preference
    a. Fixed machine panel setting provides fixed, constant power level when foot pedal is activated
    b. Linear surgeon control setting allows surgeon to increase phacoemulsification power level in linear fashion depending on how far foot pedal is depressed
3. Power setting on machine console:
    a. Displayed as percentage of maximum stroke length or oscillation (torsional or elliptical) (e.g., 50% is more power than 25%)
    b. Determines maximum power that can be achieved when foot pedal is fully depressed
    c. Is an adjustable variable that can be programmed on console (e.g., according to nuclear density)
4. Increased "power"
    a. Generates more tissue destruction and cutting ability
    b. Necessary for denser grade nuclei
    c. Generates greater repelling force and can generate greater heat

C. Excessive phacoemulsification "power" and time

1. Increases heat production at tip - increases risk of incision burn
2. May lead to endothelial cell trauma and corneal edema
3. Greater repelling forces may cause excessive particle turbulence that may lead to increased endothelial cell loss

II. Ultrasound power modulations

A. Refers to ability to program various power delivery patterns

B. Continuous mode

1. When foot pedal is activated, tip is constantly vibrating
2. Typically used for sculpting of nucleus
3. Compared to other modalities, results in greatest amount of ultrasound energy delivered to eye per unit of

time

C. Pulse mode

1. When foot pedal is activated, ultrasound automatically cycles on, then off
2. Frequency of pulses can be programmed and is measured as "pulses per second"
3. Because of on/off cycling, less power is delivered compared to using continuous mode for same length of time
4. Often used for evacuating nuclear quadrants and fragments
    a. Reducing duration of ultrasound application generally reduces repelling forces and allows suction to act on tissue in between periods of ultrasound. Rather than deflecting off of tip, mobile particles tend to follow each other better through phaco tip ("followability")
5. Advanced power modulation settings allow for programmable duty cycles with variable on/off intervals and variable (linear) control of power
    a. Increasing off interval increases "followability", reduces total energy used and reduces heat buildup at tip
    b. With linear control of power further foot pedal depression results in increased power

D. Burst mode

1. When foot pedal is activated, a single burst of phacoemulsification energy is delivered spaced at variable intervals depending on the foot pedal
2. This significantly limits amount of phacoemulsification power delivered
3. Clinically used to impale denser nuclear material onto tip for chopping
4. As foot pedal is depressed further, bursts occur more frequently and when pedal is depressed fully, phacoemulsification energy becomes continuous

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Schriefl SM1, Stifter E, Menapace R. Impact of low versus high fluidic settings on the efficacy and safety of phacoemulsification. Acta Ophthalmol. 2014 Sep;92(6):e454-7. doi: 10.1111/aos.12200. Epub 2013 Jun 20.
3. Doors M1, Berendschot TT, Touwslager W, Webers CA, Nuijts RM. Phacopower modulation and the risk for postoperative corneal decompensation: a randomized clinical trial. JAMA Ophthalmol. 2013 Nov;131(11):1443-50. doi: 10.1001/jamaophthalmol.2013.5009.

Phacoemulsification fluidics

I. Irrigation (infusion)

A. Inflow must keep pace with outflow to provide a "stable" (i.e., consistently deep) chamber

1. Incision width must be appropriate for size of phaco tip and type of tubing to maintain closed system (See Incision construction)
2. Chamber will collapse if accidentally disconnected or bottle empties

B. Maintains anterior chamber depth by gravity or forced infusion

1. Gravity-based infusion
    a. Pinch valve controlled by foot pedal (On in position 1-3)
2. Forced infusion
    a. Gravity not needed
    b. Bottle height is not adjusted, rather the desired infusion pressure is selected

C. Reasons to increase infusion

1. Poor chamber stability, excessive fluctuation of chamber depth

D. Reasons to decrease infusion

1. Desire to reduce infusion pressure head - e.g., following posterior capsule rupture
2. Excessive chamber deepening (e.g. loose zonules, post-vitrectomy eyes)

II. Venturi pump

A. Aspiration vacuum and flow are linked and do not function as separate variables as in a peristaltic pump system

1. Vacuum and flow rise together in linear fashion
2. Vacuum does not require occlusion to build with very rapid response time

III. Peristaltic pump aspiration - clinical variables

A. Aspiration flow rate ("flow rate")

1. Denotes speed of pump wheel revolutions
    a. Measured in cc/min
    b. Surgeon programs the aspiration flow rate
        i. During phacoemulsification and, cortical irrigation and aspiration (I/A), may use linear control via foot pedal
2. Affects how fast events occur in the eye
    a. Increase flow rate if events are progressing too slowly
    b. Reduce flow rate if encountering complications, such as posterior capsule rupture or iris attraction
    c. Reduced flow rate may decrease post-occlusion surge
    d. Reduced flow rate may improve stability in post-vitrectomy eyes
3. Prior to occlusion, affects the ability to draw tissue to the tip
    a. Increased flow rate means increased ability to attract particles
4. In a classic peristaltic system flow rate is directly linked to vacuum rise - new machine software technologies

vacuum rise to be adjusted independent of flow rate

B. Vacuum level

1. Denotes the vacuum level in between the occluded phaco tip and the peristaltic pump
    a. Measured in mm/Hg
    b. Surgeon programs the maximum vacuum setting
        i. Pump will not allow vacuum to rise above this preset level
        ii. Maximum vacuum level not controlled by foot pedal during phacoemulsification
        iii. During cortical irrigation & aspiration, may use linear control via foot pedal
    c. Decreasing the vacuum is helpful if there is a need to slow events down
2. Requires the tip to be occluded before the pump can generate increased vacuum
    a. Clinically affects holding power - ability of phaco tip to grip lens material
    b. During sculpting, vacuum is much less important or desirable because the tip is usually not occluded and holding power (purchase) is not needed
    c. Lack of vacuum buildup may indicate failure to occlude the phaco tip fully
3. Low vacuum
    a. Appropriate for sculpting to avoid abrupt tissue aspiration if the tip becomes occluded
    b. "Zero" or extremely low vacuum can be dangerous with some machines because the pump may stop and a incision burn can result
4. High vacuum
    a. Higher vacuum maximizes tissue holding power at the phaco tip
    b. As vacuum level is increased, the tendency for post-occlusion surge will increase

C. Post-occlusion surge

1. Reduced incidence with newer machines, tubing and settings
2. What causes surge?
    a. When tip occlusion breaks at the maximum vacuum level, the compliance or elasticity of the system causes a sudden surge of suction
    b. Tissue or anterior chamber fluid may abruptly rush into the tip
3. What are the signs and sequelae of post-occlusion surge?
    a. This sudden surge of fluid outflow can collapse the anterior chamber
    b. Lesser degrees of surge can cause movement of the iris, cornea, or posterior capsule
    c. If the capsule is not shielded by nucleus or a second instrument, surge can cause abrupt aspiration and rupture of the peripheral or posterior capsule
4. What machine adjustments should be made if excessive surge is noticed?
    a. Understanding the dynamics that lead to surge is important in reducing it clinically. Limiting occlusion will limit surge.
    b. Reducing the maximum vacuum setting is the most important step
    c. Elevating the infusion bottle height and lowering the aspiration flow rate will also tend to decrease surge
5. Equipment/machine strategies to reduce surge
    a. Advanced, vacuum-sensing pumps (e.g., fluid venting instead of air venting)
    b. Stiffer, low compliance aspiration tubing and/or cassette
    c. Phaco needle design
        i. Narrower shafts that restrict flow (micro tips, flare tips)
    d. Specialized strategies that are not part of core knowledge (e.g., cruise control, coiled tubing,

positive pressure infusion pumps, high infusion sleeves, Aspiration Bypass Stabilizer (ABS) tip)

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.30-32. Acta Ophthalmol. 2014 Sep;92(6):e454-7. doi: 10.1111/aos.12200. Epub 2013 Jun 20.
3. Impact of low versus high fluidic settings on the efficacy and safety of phacoemulsification.
4. Comparison of occlusion break responses and vacuum rise times of phacoemulsification systems. Sharif-Kashani P, Fanney D, Injev V. BMC Ophthalmol. 2014 Jul 30;14:96. doi: 10.1186/1471-2415-14-96.

Anterior capsulotomy - capsulorrhexis and can opener

Continuous curvilinear capsulorrhexis (CCC)

I. List the advantages

A. Increases the resistance of the capsular bag to tearing during phacoemulsification

B. Encases intraocular lens (IOL) in the capsular bag - optimizing centration

C. CCC that overlaps the edge of the optic x 360 degrees decreases posterior capsular opacification incidence

D. After CCC, anterior capsule can support posterior chamber IOL (with or without CCC- optic capture) if the posterior capsule is compromised

E. Isolates lens implant from uveal and vascular tissue

II. List potential challenges

A. Large brunescent nucleus (if CCC diameter is too small)

B. Cannot visualize the anterior capsule

C. Capsular fibrosis

D. Insufficient dilation

III. List the alternatives to this procedure

A. Can opener capsulotomy

B. Femtosecond laser capsulotomy

IV. Describe the instrumentation, anesthesia and technique

A. Anterior chamber kept inflated with ophthalmic viscosurgical device (OVD) or continuous irrigation for adequate control of posterior pressure and flattening of the anterior lens curvature

B. Anterior capsule incised with needle, cystotome, or forceps tips

C. Anterior capsule is torn with either needle, cystotome, or capsule forceps

V. List the complications of the procedure, their prevention and management

A. Complications

1. During the capsulorrhexis, tear escapes to periphery
2. CCC is torn or cut with phaco tip or second instrument
3. A single radial tear in the CCC may "wrap around" the equator and extend to the posterior capsule
4. A CCC that is too small may lead to posterior capsule compromise during hydrodissection in the presence of a dense nuclear sclerotic cataract
5. A CCC that is too small hampers the procedure (e.g., cortical cleanup, IOL insertion)
6. A CCC that is too small can lead to excessive anterior capsule fibrosis, diameter shrinkage, and capsulophimosis; can reduce peripheral fundus visualization

7. Too large a CCC will eliminate the advantage of overlap of the IOL edge, and may affect centration or allow for anterior displacement of IOL

8. Must discontinue efforts at CCC if the tear has encountered the peripheral zonules

B. Prevention of complications (e.g. radial tear)

1. If visualization poor, employ capsular dye

2. Replenish OVD if the chamber is shallow

3. If capsule is under stretch (i.e. hypermature cataract) use highly visco cohesive OVD to stabilize

4. Familiarity with capsule rescue techniques

5. Capsulorrhexis through a microincision utilizing specially designed microincision forceps may be useful in complicated cases by preventing loss of OVD through the larger phacoemulsification incision and the resulting shallowing of the anterior chamber

C. Management of complications

1. Attempt to rescue escaping radial tear using above steps

   a. With AC refilled with OVD, lay anterior flap back down in anatomic pre-tear position, then pull flap in reverse tangential direction, i.e., pull force directed back along existing tear rather than ahead of tear (Little technique)

2. If radial tear is too peripheral, abandon the tear and consider additional relaxing incisions, tearing from the opposite direction, or converting to a can-opener capsulotomy.

3. If continuous CCC diameter is too small, perform secondary enlargement after the IOL is implanted

4. Deepen anterior chamber with additional viscoelastic if the capsulorrhexis is starting to migrate peripherally. Shallowing of the AC will encourage the rhexis to tear peripherally and should be avoided

Can-opener capsulotomy

I. List the advantages

A. Easier to perform particularly if visualization is poor

B. Easier to make a large diameter capsulotomy, compared to CCC

C. Regardless of size, will not trap the nucleus from delivery anteriorly

II. List the disadvantages

A. Loss of the advantages of the CCC listed above

III. Describe the instrumentation

A. Cystotome, such as bent needle

B. Anterior chamber inflated with OVD or irrigation (via cystotome)

IV. List the complications of the procedure

A. Large hinged flap of capsule may result from incomplete capsulotomy

1. Inadvertent aspiration can tear into posterior capsule

2. Incarceration in incision may not be recognized

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.41-42.

3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

4. Hengerer FH, Dick HB, Kohnen T, et al. Assessment of intraoperative complications in intumescent cataract surgery using 2 ophthalmic viscosurgical devices and trypan blue staining. J Cataract Refract Surg. 2015 Apr;41(4):714-8.

5. Little BC, Simth JH, Packer M. Little capsulorhexis tear-out rescue. J Cataract Refract Surg 2006:32:1420-2.

Hydrodissection and hydrodelineation

Hydrodissection

I. Purpose

A. Permits rotation of the nucleus by severing cortical attachments to capsule

B. Facilitates cortex removal (hydrates and loosens cortical capsular attachments)

1. Reduces zonular stress in high risk cases

II. Describe the instrumentation and technique

A. Syringe with hydrodissection cannula

B. Can use balanced salt solution (BSS), lidocaine, or ophthalmic viscosurgical device (OVD)

C. Cannula tip is positioned beneath continuous curvilinear capsulorrhexis (CCC) edge

D. Capsule edge is tented upward in cortical-cleaving hydrodissection

E. Fluid wave is directed toward and along internal surface of the capsular bag

F. Wave passes posteriorly behind the nucleus causing slight elevation

G. Nucleus is pressed downward to break capsulorrhexis-lenticular block, and to propagate the fluid wave in addition to breaking cortical capsular connections

H. Lens is rotated to loosen connections to capsular bag

III. List the complications of the procedure, their prevention and management

A. Failure to loosen nucleus or epinucleus

1. Greater forces imparted to capsular bag/zonules during attempted rotation
2. Increased risk of posterior capsule rupture if the nucleus does not rotate

B. Prolapse of nucleus such that it is captured by the CCC partially or wholly in anterior chamber (more problematic with denser nucleus)

1. Gently reposition the nucleus back into bag (if intact)
2. Debulk nucleus by chopping or sculpting

C. Intraoperative capsular block

1. Elevation of nucleus into the CCC can create intraoperative capsular block
2. Continued infusion results in trapped fluid which can create significant posterior capsule pressure
3. This can rupture the posterior capsule particularly if the posterior capsule is weak such as in posterior polar cataract or if the capsule has a preexisting injury following trauma or vitrectomy
4. Gently push down on nucleus and lift anterior capsule with cannula to relieve block and release trapped BSS

D. Use caution with hydrodissection in patients with posterior polar cataract, posterior capsular injury from vitrectomy or intravitreal injection, or trauma

1. Use of OVD for viscodissection may decrease chance of capsular aspiration and damage during phacoemulsification

E. Separation of canula from syringe during fluid ejection

1. Use Luer-lock syringe

I. Purpose

A. Separates epinucleus from the endonucleus

1. Reduces overall size of the portion of nucleus that must be chopped or sculpted
2. During removal of last nuclear fragments, epinuclear shell can stabilize and protect posterior capsule, restraining it from trampolining toward the exposed phaco tip

B. Optional step

1. May be useful technique in situations with compromised capsules, small pupils

II. Describe the instrumentation and technique

A. Same as hydrodissection instrumentation

B. During injection, tip is directed into the peripheral nucleus along a more oblique internal tissue plane

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.42-43, 55, 194.

Phacoemulsification techniques - nuclear removal

I. Nucleus disassembly

A. Fragmenting nucleus to permit removal of smaller pieces through continuous curvilinear capsulorrhexis (for in-the-bag techniques)

B. May include hydrodelineation and separation of epinucleus

C. Concept can be applied to in-the-bag phacoemulsification, or to supracapsular phacoemulsification

D. Common methods include divide and conquer and phaco chop

E. Supra capsular techniques involve flipping the nucleus out of the capsular bag after prolapsing one pole, which may be useful in selected situations (soft nuclei, post-vitrectomy eyes, high myopia, and zonular trauma / zonulopathy)

II. Divide and conquer

A. In-the-bag technique

B. Deeply sculpted trough allows manual fracture into two hemi-pieces

C. Quadrants are similarly created and elevated out of the bag

D. Advantages

1. No need to flip large nucleus out of bag
2. Relatively minimal coordinated movements of second instrument and phaco tip (compared to chopping)
3. Blind maneuvers minimized

E. Disadvantages

1. Requires more ultrasound energy than chopping techniques which can lead to corneal endothelial damage
2. Technique is difficult when the nucleus is very soft

III. Phaco chop

A. In-the-bag technique

B. Chopper fragments endonucleus manually

1. Horizontal chop - during the chop, the chopper tip is placed near the lens equator and moves toward the phaco tip in the horizontal plane.
2. Vertical chop- the chopper tip is placed above and slightly peripheral to the embedded phaco tip near the center of the nucleus. The instruments are moved toward each other in the vertical plane and apart in the horizontal plane
3. Stop and chop - a single deep trough is sculpted and the nucleus is manually fractured into two pieces. The two pieces are further disassembled using a chop technique

C. Advantages

1. Sculpting decreased or eliminated in favor of manual chopping
    a. Decreased phaco energy
    b. Decreased stress on zonules
2. Excellent technique for soft nuclei as well as hard

D. Disadvantages

1. Compared to divide and conquer, much greater coordination of second instrument with phaco tip
2. Horizontal chop may require relatively blind placement of chopper tip if pupil not widely dilated

IV. Equipment

A. Phaco handpiece can be coaxial or biaxial

1. Coaxial has integrated phaco, irrigation and aspiration
    a. Requires one small paracentesis incision and one larger incision (approximately 2.4+mm) to accommodate larger handpiece
2. Biaxial (or "bimanual") has one handpiece for aspiration and phaco and another handpiece for aspiration
    a. Requires two incisions (approximately 1.4mm each)
    b. Allows for easier access of sub-incisional cortex
    c. May reduce phaco power and time, as well as post-operative corneal astigmatism

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Henderson BA, Pineda R, Chen SH. Essentials of Cataract Surgery Slack Incorporated 2014.
3. Yu JG, Zhao YE, Shi JL, et al. Biaxial microincision cataract surgery versus conventional coaxial cataract surgery: metaanalysis of randomized controlled trials. J Cataract Refract Surg. 2012 May;38(5):894-901.
4. Chang, DF. Phaco Chop and Advanced Phaco Techniques: Strategies for Complicated Cataracts Slack Incorporated, 2013.

Capsule staining

I. List the indications

A. Inability to visualize the anterior capsule adequately

B. Pediatric cataracts (to reduce elasticity of capsule)

II. List the alternatives to this procedure

A. Can opener capsulotomy

B. Laser capsulotomy

C. External light pipe and radiofrequency blade have been described but are not in wide use

III. Describe the instrumentation and technique

A. Trypan blue is Food and Drug Administration (FDA) approved

B. Most global experience with Indocyanine green (ICG) and Trypan blue

C. Stain anterior capsule beneath air bubble or ophthalmic viscosurgical device (viscoelastic) or with direct intracameral injection

IV. List the complications of the procedure

A. Some dyes are toxic

1. Methylene blue is toxic to corneal endothelium and should not be used
2. ICG diluent is not physiologic for the anterior chamber
    a. ICG is reconstituted with balanced salt solution (BSS)+ for proper pH and osmolality

B. Trypan blue may increase stiffness of anterior capsule

C. Risk of staining vitreous if zonular dehiscence, potentially compromising red reflex

Additional Resources

1. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.42.
2. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
3. Hengerer FH, Dick HB, Kohnen T. Assessment of intraoperative complications in intumescent cataract surgery using 2 ophthalmic viscosurgical devices and trypan blue staining. J Cataract Refract Surg. 2015 Apr;41(4):714-8.
4. Hengerer FH, Dick HB, Kohnen T, et al. Effect of trypan blue staining on the elastic modulus of anterior lens capsules of diabetic and nondiabetic patients. J Cataract Refract Surg 2009; 35:318-323.

Clear lens extraction - refractive lensectomy

I. Indications/contraindications

A. Elective procedure to improve refractive error via phacoemulsification of crystalline lens and intraocular lens implantation

1. Assumes visually significant cataract not present
2. Typically used in high hyperopia or high myopia
    a. Significant risk of retinal detachment in high myopia
        i. Retinal detachment risk relatively reduced in high myopes over the age of 50
3. Presbyopia correction also possible

B. May benefit patients who are glasses intolerant and prone to contact lens-related corneal pathology

1. Risks of further corneal injury may outweigh risks of lensectomy

C. Advantage in avoiding 2 procedures

1. Laser vision correction does not obviate need for cataract surgery in future
2. May be the ideal procedure in older patients who are on the verge of developing cataract

D. Controversial in myopia because of increased retinal detachment risk

1. Higher risk of retinal detachment associated with younger age, longer axial lengths

E. Relative disadvantage for young patients because of loss of accommodation

F. Generally contraindicated if higher risks to lens extraction (e.g., chronic uveitis, fellow eye retinal detachment, Fuchs endothelial dystrophy, uveal effusion syndrome in high hyperopes)

G. Off-label use of IOL

II. Pre-procedure/therapy evaluation

A. Trial of non-surgical options, e.g., contact lenses

B. Accurate IOL prediction and astigmatism control and modification

C. Informed consent

1. Retinal detachment
2. Surgical presbyopia
3. Refractive surprise (more likely with high myopes and high hyperopes) and possible need for postoperative enhancement with corneal refractive surgery or glasses for residual refractive error
4. Discussion of multifocal IOLs should include potential of unwanted optical images

III. Alternatives to this procedure/therapy

A. Contact lenses and glasses

B. Corneal refractive surgery

C. Phakic IOL surgery

Additional Resources

1. AAO, Focal Points: Advances in Small Incision Cataract Surgery, Module #9, 2000, p.2-3.

2. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

3. Westin O, Koskela T, Behndig A. Epidemiology and outcomes in refractive lens exchange surgery. Acta Ophthalmol. 2015 Feb;93(1):41-5.

Intraocular lens material and design

I. List the indications/contraindications

A. Intraocular lenses (IOLs) are indicated for the surgical correction of aphakia.

B. Most IOLs are composed of acrylic, silicone, or polymethylmethacrylate (PMMA), or collagen copolymer ("Collamer") material

C. IOL implantation is contraindicated in the presence of uncontrolled active uveitis (with the exception of Fuchs heterochromic uveitis)

D. Considerations in selection of IOLs include

1. Availability of correct power to achieve the desired postoperative refraction
2. Compatibility of IOL design, selected intraocular location (bag, sulcus, iris, anterior chamber) and fixation method (haptic, suture)
3. Biocompatibility of IOL material and IOL design for reduction of uveal reaction for reduction of capsular opacification or fibrosis
4. Compatibility of IOL with other surgical devices used concurrently (e.g., silicone oil in the vitreous cavity)
5. Interaction of optic and haptic size and location with capsulorrhexis and pupil size
6. Requirement for incision size and availability of insertion system (injector, forceps, etc.)
7. Special ocular conditions necessitating adjunctive devices or unique designs (aniridia, iridectomy, ectopia lentis)

II. Describe the pre-procedure/therapy evaluation

A. A comprehensive eye examination is required prior to implantation of an IOL

B. Special consideration should be given to concomitant ocular pathology such as corneal endothelial compromise, glaucoma, uveitis, macular degeneration and diabetic retinopathy

C. Assist the patient in setting reasonable expectations regarding the outcome of surgery

D. Biometry, keratometry and IOL power calculation are necessary to determine the correct power of the IOL to be implanted

1. Primary location
    a. Usually within the capsular bag
    b. Certain IOLs must be placed only in an intact capsular bag (e.g., plate haptic or accommodating IOL)
2. Secondary locations
    a. Ciliary sulcus (with or without scleral or iris suture fixation or optic capture)
    b. Anterior chamber

III. List the alternatives to this procedure/therapy

A. Aphakia with contact lens (monocular) or eyeglass correction (binocular)

B. A large variety of IOLs are available today for the correction of aphakia

C. The choice of a particular design of IOL for any given patient is guided by multiple factors, including but not limited to

1. The desire of the patient for eyeglass independence
2. The relative importance to the patient of achieving optimal optical quality
3. Anatomical or pathophysiologic factors determined by the surgeon during the preoperative examination

a. Keratometric astigmatism

b. Corneal spherical aberration

c. Pupil size and pathology

d. Competence of the zonular-capsular apparatus

D. Examples of significant elements of the decision-making process for selection of a particular IOL include (but are not limited to)

1. Eyeglass independence (multifocal or accommodative IOL)

   a. Aversion to halos or dysphotopsia ➔ accommodative rather than multifocal

2. Correction of astigmatism (toric IOL and/or limbal relaxing incisions, astigmatic keratotomy, or laser vision correction)

3. Desire for optimal optical quality

4. The absence of capsular support where suture fixation or implantation of an anterior chamber IOL may be required

5. Congenital or traumatic aniridia

6. Intraoperative compromise to the capsular bag

7. The presence of (or future need for) silicone oil in the vitreous cavity, in which case an acrylic IOL is preferred, and a silicone IOL is contraindicated

8. Pupil size under various lighting conditions

IV. Describe the instrumentation, anesthesia and technique

A. IOL insertion

1. Forceps

2. Cartridge delivery system

3. Hooks and manipulators for positioning (e.g., Sinskey or Lester hook)

4. Viscoelastic devices

B. Anesthesia

1. Topical

2. Intracameral

3. Peribulbar

4. Retrobulbar

5. General

   a. General usually reserved for children and for special circumstances in adults

6. Topical and peri-ocular methods are most common today

C. Technique

1. Varies with specific model of IOL and insertion device

2. Each surgeon must become familiar with the particular nuances of each IOL insertion system being used

V. List the complications of the procedure/therapy, their prevention and management

A. Optical complications

1. Significant ametropia (postoperative refractive error)

   a. Prevention

      i. Accurate biometry

ii. IOL calculation

iii. Intraoperative verification of IOL power (human error)

b. Management

i. Piggyback IOL

ii. IOL exchange

iii. Keratorefractive surgery

iv. Contact lens

v. Spectacles unless large anisometropia

2. Dysphotopsia without significant capsular opacification

a. Prevention

i. Appropriate IOL optic size relative to pupil size

ii. Appropriate choice of IOL optic design (convexity, refractive index, edge design, mono- vs. multi-focality)

iii. Primary sulcus placement in at risk patients

b. Management

i. Time (observation)

ii. Brimonidine

iii. Weak pilocarpine

iv. Minus eyeglasses

v. IOL repositioning

vi. IOL exchange

vii. Piggyback IOL

viii. Reverse optic capture for negative dysphotopsias

3. Posterior capsular opacification

a. Prevention

i. Square or truncated optic edge design that induces capsular bend

ii. Capsulorrhexis overlying edge of optic 360°

iii. Cortical cleaving hydrodissection

iv. Meticulous cortical clean-up

v. In-the-bag implantation of IOL

b. Treatment

i. Nd: YAG capsulotomy of visually significant opacification

4. Anterior capsular fibrosis/phimosis (See Anterior capsule fibrosis and phimosis)

a. Prevention: adequate capsulorrhexis size

b. Management: YAG capsulotomy (anterior capsule)

c. Capsular tension ring may aid in prevention of cases with zonular pathology

B. Mechanical complications

1. Subluxation/dislocation

a. Prevention

i. Secure location, with suture if necessary

ii. Position and stability of the IOL should be ascertained prior to concluding surgery

b. Management

i. Suture fixation (iris, sclera)

ii. Repositioning

iii. IOL exchange

c. IOL dislocation following Nd: YAG capsulotomy (e.g., plate haptic IOLs)

C. Biological complications

1. Uveitis/glaucoma/hyphema (mechanical irritation of the uvea)

a. Prevention

i. Secure in-the-bag implantation

ii. Avoidance of sulcus placement of 1-piece IOL

b. Management

i. Medical management with topical, oral, sub-Tenon corticosteroids and topical non-steroidal anti-inflammatory drugs (NSAIDs)

ii. IOL repositioning or exchange

2. Descemet detachment

a. Prevention

i. Safe clearance of Descemet membrane at internal incision edge

ii. Minimizing surgical trauma

b. Management

i. Observation if small and localized

ii. Air/gas tamponade with or without suture

iii. Endothelial keratoplasty in severe cases not improved with other measures

VI. Describe the follow-up care

A. Topical antibiotic and anti-inflammatory agents

B. Examination at 1 day; 1 - 4 weeks

C. Post-operative refraction at 2 - 6 weeks

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.21, 94-100,112, 120-151.
3. Apple DJ, Mamalis N, Olson RJ, et al. Intraocular Lenses: Evolution, Designs, Complications, and Pathology. Baltimore: Williams & Wilkins; 1989.
4. Sacu S, Menapace R, Findl O. Effect of optic material and haptic design on anterior capsule opacification and capsulorrhexis contraction. Am J Ophthalmol 2006;141:488-493.
5. Findl O, Menapace R, Sacu S, et al. Effect of optic material on posterior capsule opacification in intraocular lenses with sharp-edge optics: randomized clinical trial. Ophthalmology 2005;112:67-72.
6. AAO, Focal Points: Refractive Lens Exchange, Module #6, 2007.

Toric intraocular lenses (IOLs)

I. List the indications/contraindications

A. The Food and Drug Administration has approved multiple toric IOLs, including plate haptic, single piece acrylic, and accommodative designs

B. Indications

1. Surgical correction of corneal astigmatism

C. Contraindications

1. Capsular bag damage
2. If patient plans to wear rigid hard contact lens postoperatively
3. Irregular astigmatism (e.g., post-penetrating keratoplasty, keratoconus)

II. Describe the pre-procedure/therapy evaluation

A. Accurate biometry, keratometry and IOL power calculation are necessary to determine the correct power of the IOL to be implanted

B. Corneal topography is a useful adjunctive procedure

1. Determining simulated keratometry
2. Revealing keratoconus or significant irregular astigmatism

III. List the alternatives to this procedure/therapy

A. Standard monofocal IOL implantation in combination with keratorefractive surgery

1. Laser vision corrections: photorefractive keratectomy, LASIK
2. Limbal relaxing incisions/astigmatic keratotomy
3. Spectacle correction
4. Contact lenses

IV. Describe the instrumentation, anesthesia and technique

A. It is critical to mark one or more principal meridians of the cornea while the patient is sitting up to avoid the effect of cyclotorsion on supination.

1. The steep axis of the cornea is then marked intraoperatively using the marks placed preoperatively as a guide

B. Alternatively, surgical guidance systems utilizing iris registration or intraoperative aberrometry can guide toric positioning

C. The IOL is injected into the capsular bag with an insertion system available from the manufacturer

D. The IOL is rotated into the proper position prior to removing ophthalmic viscosurgical device (OVD) (viscoelastic) from the capsular bag.

E. With the single-piece acrylic toric lenses, the IOL should be rotated to a position approximately 1 clock hour counterclockwise from the final desired position so that it can be easily rotated to the correct position following removal of the OVD

F. Anesthesia: topical, intracameral, peribulbar, retrobulbar, general

G. Additional astigmatic correction may be applied using limbal relaxing incisions or other keratorefractive procedures (e.g. LASIK or PRK)

V. List the complications of the procedure/therapy, their prevention and management

A. Rotation or other movement of the IOL may reduce its efficacy or even worsen pre-existing astigmatism if extreme

1. Rotation typically occurs early i.e. 24 - 48 hours
2. Each degree of off-axis rotation reduces astigmatism correction by approximately 3%
3. 30 degrees of rotation will result in total loss of any astigmatic correction
4. Spontaneous rotation may be more common in patients with high axial myopia and large anterior segments
5. Repositioning may be necessary and should be completed before capsular fixation of the lens, typically within 4-weeks post-op
    a. Placement of a CTR has been described in cases of repeat IOL rotation

B. Incorrect axis marking may worsen pre-operative astigmatism

VI. Describe the follow-up care

A. Topical antibiotic and anti-inflammatory agents

B. Examination at 1 day; 2 - 4 weeks

C. Post-operative refraction at 2 - 6 weeks

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Horn JD. Status of toric intraocular lenses. Curr Opin Ophthalmol 2007;18:58-61.

Intraocular lens calculation following refractive surgery

I. List the indications/contraindications

A. Indications

1. Any candidate for cataract surgery with intraocular lens (IOL) implantation or refractive lens exchange who has undergone prior keratorefractive surgery, including radial keratotomy (RK), photorefractive keratectomy (PRK), laser thermal keratoplasty (LTK), conductive keratoplasty (CK), LASIK, LASEK, and epi-LASIK

II. Describe the pre-procedure evaluation

A. History of refractive surgery and review of old records, if available

1. If prior RK surgery question patient if they are experiencing diurnal fluctuation

B. Comprehensive eye examination, including

1. Visual acuity
2. Refraction
3. Tonometry
4. Slit-lamp biomicroscopic examination
5. Dilated ophthalmoscopic examination
6. Corneal topography/tomography

III. List the alternatives to this procedure

A. IOL implantation with standard calculation techniques and likely post-operative ametropia

IV. Describe the instrumentation and technique

A. Instrumentation

1. Keratometer
2. Biometry: A scan (ultrasonic) or partial coherence interferometer (optical)
3. Corneal topography/tomography
4. IOL calculation software and compatible computer hardware
5. Online post-refractive IOL power calculators (http://iolcalc.org)

B. Techniques

1. Corneal topography method
    a. The effective refractive power of the cornea may be calculated from topographically obtained values, over central cornea
    b. May be used effectively in post-RK eyes
    c. Requires adjustment in post-PRK or LASIK eyes
2. Use of late generation IOL calculation formulae (i.e., Holladay 2, Haigis L, Shammas, Masket, OCT-based, Barrett, and/or double K method)
3. Clinical history method

a. Change in manifest refractive spherical equivalent due to keratorefractive surgery is subtracted from preoperative mean keratometry value

b. The difference is used as the K value in the IOL calculation formula of choice

c. Need recent manifest refraction after keratorefractive surgery prior to development of cataract

V. List the complications of the procedure, their prevention and management

A. Postoperative refractive surprise

B. Each type of refractive surgery presents differing problems for IOL calculation

C. No general consensus on best approach to IOL power calculation after keratorefractive surgery or best IOL calculation formulas to use

1. Radial keratotomy - traditional keratometric reading inaccurate because of induced central corneal flattening
    a. Prevention
        i. Contact lens overrefraction, clinical history method or corneal topography can help determine true central corneal power
        ii. Could consider suture stabilization (Lasso) to prevent visual fluctuation due to corneal instability
    b. Management
        i. Implantation of the correct IOL in eyes with prior radial keratotomy generally results in early post-operative hyperopia
        ii. The eye may require 3-9 months for the refraction to stabilize
        iii. IOL exchange or placement of a piggyback IOL for management of post-operative ametropia should not be undertaken until refractive stability has been achieved
2. Myopic laser vision correction surgery -
    a. traditional keratometric readings, automated refractors and topographers may be incorrect because of surgical alteration of anterior corneal curvature
    b. Alteration of the relationship between the anterior and posterior corneal curvatures may lead to an inaccurate estimation of corneal power
    c. Tendency for hyperopic refractive surprise after cataract surgery
    d. Prevention
        i. Use of formulas to help determine IOL power after refractive surgery
3. Hyperopic photoablation surgery
    a. Tendency for myopic refractive surprise after cataract surgery
    b. Prevention
        i. Use of formulas to help determine IOL power after refractive surgery
4. Patient education
    a. Potential inaccuracies of IOL power calculation
    b. Additional surgery may be needed to achieve spectacle independence

D. Intraoperative wavefront aberrometry

1. May be helpful in post LASIK eyes by measuring the wavefront aberrometry intraoperatively after the crystalline lens has been removed
2. Especially useful when post refractive formulas give a wide range of potential IOL powers
3. May not be useful in post RK eyes due to stretching of RK incisions during phacoemulsification with resulting flatter corneal powers during wavefront measurement that will abate several months after surgery
4. Further studies will ultimately be needed to better define its usefulness and efficacy in post refractive IOL

calculations

VI. Describe the considerations in interpretation of this diagnostic procedure

A. Standard keratometry inaccurately reflects corneal refractive power after keratorefractive surgery

B. Careful keratometric measurement and calculation, including the use of an optimized IOL constant and advanced formulae will add to the accuracy of IOL power selection

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Holladay JT. Cataract surgery in patients with previous keratorefractive surgery (RK, PRK, and LASIK). Ophthalmic Practic. 1997;15:238-244.
3. Seitz B, Langenbucher A, Nguyen NX, et al. Underestimation of intraocular lens power for cataract surgery after myopic photorefractive keratectomy. Ophthalmology. 1999;106:693-702.
4. Seitz B, Lagenbucher A. IOL power calculations in eyes after refractive surgery. Presentation at American Academy of Ophthalmology Subspecialty Day. Refractive Surgery 1998: Reshaping the Future [on CD-ROM].
5. Aramberri J. Intraocular lens power calculation after corneal refractive surgery: double K method. J Cataract Refract Surg. 2003;29:2063-2068.
6. Hamilton DR, Hardten DR. Cataract surgery in patients with prior refractive surgery. Curr Opin Ophthalmol. 2003 Feb;14(1):44-53.

Special cases: primary piggy-back lenses

I. List the indications/contraindications

A. For patients with highly hyperopic or myopic eyes, a single intraocular lens (IOL) may not be available with sufficient power to produce emmetropia

B. Contraindications

1. Similar for IOL implantation in general, i.e., active uncontrolled uveitis
2. Corneal edema or edema on awakening
3. Corneas at 620-640 microns or greater are at greater risk
4. Significant ocular comorbidities

II. Describe the pre-procedure/therapy evaluation

A. The use of a newer regression formula, such as the Holladay II or other late generation formulae, incorporating the measured anterior chamber depth, lens thickness and corneal diameter, is especially helpful in extremely short eyes where piggyback IOLs are required to achieve emmetropia

III. List the alternatives to this procedure/therapy

A. Correcting postoperative refractive error with a contact lens, eyeglasses or corneal refractive surgery (bioptics)

IV. Describe the instrumentation, anesthesia and technique

A. Lenses are selected to place one IOL in the bag and one IOL in the sulcus or both in the bag (usually not two acrylic IOLs)

B. Placement of two acrylic lenses in the bag has been associated with interlenticular fibrosis and loss of refractive power

C. No plate haptic or one piece IOL in sulcus

V. List the complications of the procedure/therapy, their prevention and management

A. Interlenticular opacification

1. Occurs with multiple acrylic IOLs in the capsular bag
2. Nd: YAG discission
3. IOL explantation

B. Significant ametropia

1. IOL exchange of sulcus piggyback lens
2. IOL exchange of both IOLs for a single IOL
3. Laser vision correction

C. Optic capture of the iris

D. Chronic uveitis or uveitis-glaucoma-hyphema (UGH) syndrome

E. Chronic secondary angle closure

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Special cases: secondary piggy-back lenses

I. List the indications/contraindications

A. For the correction of residual postoperative refractive error or intractable negative dysphotopsias, a low powered plus or minus intraocular lens (IOL) is placed in the ciliary sulcus following posterior chamber intraocular lens implantation in the capsular bag

B. Contraindications:

1. Same as for IOL implantation in general, i.e., active uncontrolled uveitis (See Posterior chamber intraocular lens implantation)
2. Corneal edema or edema on awakening
3. Corneas 640 microns or greater are at greater risk
4. Glaucoma with inadequately controlled intraocular pressure and progressive visual field loss despite maximal medication suggests a need for surgical intervention either before as at the same time as IOL implantation
5. Patients with diabetes mellitus at increased risk of macular edema may benefit from preoperative evaluation by a retina subspecialist

II. Describe the pre-procedure/therapy evaluation

A. Secondary piggyback IOL implantation should be postponed at least 6 weeks after primary IOL implantation in most cases

B. Following keratorefractive surgery, implantation should be postponed until refractive stability is achieved

C. Several formulae are available to determine the appropriate power for the IOL to be implanted. (The Holladay Vergence Formula provides calculation of the power of a piggyback IOL)

III. List the alternatives to this procedure/therapy

A. Correcting postoperative refractive error with a contact lens, eyeglasses or corneal refractive surgery (bioptics)

B. IOL exchange

IV. Describe the instrumentation, anesthesia and technique

A. Polymethylmethacrylate (PMMA) or 3-piece foldable IOLs

V. List the complications of the procedure/therapy, their prevention and management

A. Interlenticular opacification:

1. Commonly occurs with two IOLs placed in the capsular bag
2. However, it has been reported with implantation of one IOL in the bag and one in the sulcus
3. Treat by Nd: YAG laser discission
4. IOL exchange if Nd: YAG discussion fails to correct the visual problems due to ILO, then surgical explantation of one of the IOLs or possibly both of the IOLs and removal of the fibrous tissue with implantation of new IOLs may be necessary to provide adequate visual rehabilitation

B. Significant ametropia

1. IOL exchange of sulcus piggyback lens

C. Pigment dispersion and chamber shallowing

D. Optic capture

E. Chronic uveitis or uveitis-glaucoma-hyphema (UGH) syndrome

VI. Describe the follow-up care

A. Topical antibiotic and anti-inflammatory agents

B. Examination at 1 day; 2-4 weeks

C. Post-operative refraction at 2 - 6 weeks

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Posterior chamber intraocular lens implantation

I. List the indications/contraindications

A. Fixation in the capsular bag is recognized as the best option for location of a posterior chamber intraocular lens (PCIOL)

B. Fixation in the ciliary sulcus, with or without suture, represents a secondary option for some PCIOLs

C. Anatomic consideration, such as synechiae or inadequate capsular support, may preclude placement of an IOL in the posterior chamber, in which case placement of an anterior chamber intraocular lens (ACIOL) or aphakia with contact lens or spectacle correction remain alternatives

II. Describe the pre-procedure/therapy evaluation

A. A comprehensive eye examination is required prior to implantation of an IOL

1. Special consideration should be given to concomitant ocular pathology such as compromised corneal endothelium, glaucoma, uveitis, macular degeneration and diabetic retinopathy

B. Biometry, keratometry and IOL power calculation is necessary to determine the correct power of the IOL to be implanted

III. List the alternatives to this procedure/therapy

A. Placement of an ACIOL or aphakia with contact lens or spectacle correction

IV. Describe the instrumentation, anesthesia and technique

A. Forceps

1. Rigid, polymethylmethacrylate (PMMA) IOL may be handled with fine, smooth forceps designed with long jaws to aid in positioning
2. The incision size must be at least equal to the optic diameter
3. The bag and anterior chamber are filled with ophthalmic viscosurgical device (OVD) (viscoelastic) (See Ophthalmic viscosurgical devices)
4. The leading haptic is inserted into the bag with all or part of the optic, and then the trailing haptic is rotated or dunked with a hook or manipulator into the capsular bag.
5. Foldable IOLs may be inserted with specially designed forceps
    a. Generally, this involves a two-step procedure, first folding the IOL with one instrument and then grasping it with the insertion forceps
    b. Silicone IOLs become difficult to grasp when wet, and should not be irrigated prior to folding
    c. Acrylic IOLs are less compliant and fold more slowly, varying with thickness and temperature
6. The leading haptic is placed in the capsular bag
7. The trailing haptic may be pushed and rotated into the bag with a hook or inserted using forceps
8. Plate haptic silicone IOLs should be inserted with an injector.

B. IOL Insertion devices

1. Most inserting "shooters" or injectors are designed with a disposable cartridge that folds the IOL and includes an injection funnel for delivering the IOL into eye
2. These are generally lubricated with OVD

3. A variety of designs are available for pushing the folded PCIOL through the cartridge funnel

    a. Syringe plungers

    b. Screw-type injectors

    c. Automated injectors

4. Each design requires nuances of technique, and it is the responsibility of the surgeon to learn the details of technique and requisite incision size for each device he or she chooses to employ

5. Once delivered into the eye the IOL may be placed in its final position with a hook, forceps, or with the irrigation/aspiration tip

V. List the complications of the procedure/therapy, their prevention and management

A. Tearing or stretching of the corneal incision may lead to poor wound sealing.

1. Enlarging the incision to the appropriate size for insertion by any technique helps to preserve wound architecture and insure a stable chamber postoperatively

B. Insertion devices may damage the intraocular lens optic or haptics, resulting in an unstable or optically inadequate IOL

1. If damage to the IOL occurs during insertion, the surgeon must be prepared to perform an immediate IOL exchange

    a. This can often be accomplished without enlarging the incision, by cutting the damaged IOL and removing the pieces from the eye, or in some cases, acrylic IOLs can be refolded and removed

    b. It is a advisable to re-assemble the pieces under the microscope to insure that no implanted material has been left behind

C. Damage to intraocular structures (e.g., lens capsule, iris, Descemet membrane) can occur during insertion of an IOL

1. The surgeon must be prepared to address loss of adequate capsular support by suture fixation of the IOL or IOL exchange

2. Large Descemet membrane detachments can be managed with air/gas tamponade

D. Incomplete insertion into the capsular bag

1. One haptic in the bag and one haptic in the sulcus

2. May result in IOL decentration

3. May result in UGH syndrome

4. Best prevented by insuring that both haptics and the optic are within the confines of the capsular bag before removing OVD

    a. Iris retraction may be needed to insure proper placement if pupil constriction has developed during the procedure

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.

3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

4. AAO, Focal Points: Sutured Posterior Chamber Intraocular Lenses, Module #9, 2006.

Special cases: ciliary sulcus fixation and capsulorhexis capture of posterior chamber intraocular lenses

I. List the indications/contraindications

A. Indications

1. When there is inadequate capsular support to stabilize an intraocular lens (IOL) within the bag, whether for the correction of long-standing aphakia or for IOL fixation following compromise of the posterior capsule during surgery

B. Contraindications

1. Same as for IOL implantation in general, i.e., active uncontrolled uveitis
2. Corneal edema or edema on awakening
3. Corneas 640 microns or greater are at greater risk for decompensation
4. Uncontrolled ocular comorbidities

C. Avoid single piece acrylic or plate haptic IOLs for sulcus placement.

D. In typical adult eyes, avoid use of smaller IOLs (e.g. 5.5 mm optic, 12.5 mm loop); use larger sizes for both optic and haptic if available

II. Describe the pre-procedure/therapy evaluation

A. A comprehensive eye examination is required prior to implantation of an IOL

B. Special consideration should be given to concomitant ocular pathology such as glaucoma, uveitis, macular degeneration and diabetic retinopathy

C. Biometry and keratometry for IOL power calculation are necessary to determine the correct power of the IOL to be implanted

1. Generally, the power of a sulcus fixated IOL should be 0.5 to 1.0 D less than that calculated for in-the-bag fixation, but this varies for IOLs of very high (1D or more) or very low power (no change in power)
2. For IOLs placed in the ciliary sulcus with anterior capsulorrhexis optic capture behind the rhexis, no alteration in IOL power is needed. The IOL optic is functionally and optically in the capsular bag

III. List the alternatives to this procedure/therapy

A. Sutured posterior chamber IOL

B. Anterior chamber IOL

C. Aphakia with contact lens or eyeglass correction

IV. Describe the instrumentation, anesthesia and technique

A. Pupil dilated pharmacologically

B. Anterior vitrectomy as needed

C. Use of OVD to protect corneal endothelium and to expand the ciliary sulcus

D. Polymethylmethacrylate (PMMA) IOLs and three-piece foldable IOLs may be appropriate for sulcus fixation depending on the haptic diameter and the size of the eye

1. The sulcus diameter may be estimated by considering the corneal white-to-white diameter and the axial length

2. A reasonable average diameter is 11-11.5 mm in adults

E. Once the ciliary sulcus has been expanded with an OVD, the IOL is inserted into the eye either via an insertion device or with forceps. The leading haptic is directed into the sulcus, and must overly the anterior capsule. The trailing haptic can then dialed into the sulcus, or bowed into position using forceps

F. Optic capture

a. Usually performed with a 3-piece PCIOL, the optic is trapped behind the capsulorrhexis and helps to maintain centration of the IOL

b. The capsulorrhexis must be centered and smaller in diameter than the optic of the IOL

2. After insertion of the IOL into the ciliary sulcus, the optic is prolapsed posteriorly through the capsulotomy opening

3. The edge of the capsule becomes oval because it wraps around the haptic-optic junctions

4. Care should be taken to assure that the loops are positioned anterior to the capsulotomy prior to optic capture

G. Consider intraoperative miotics if concerned about optic capture by the iris or vitreous prolapse

V. List the complications of the procedure/therapy, their prevention and management

A. Subluxation/dislocation

1. Prevention

a. Suture fixation may offer better stability if the anterior capsular support is compromised or uncertain

2. Management

a. Repositioning

b. Resuturing

c. IOL exchange

d. Iris fixation

B. Uveitis/glaucoma/hyphema

1. Prevention:

a. Secure implantation

b. Avoidance of single piece acrylic lens placement in sulcus

2. Management

a. Medical treatment with anti-inflammatory agents, topical glaucoma medications

b. IOL repositioning or exchange

C. Pseudophakic corneal edema

1. Prevention

a. Minimizing surgical trauma

2. Management

a. Lamellar endothelial keratoplasty

b. Penetrating keratoplasty

D. Cystoid macular edema

1. Prevention

a. Use of topical corticosteroid and NSAIDs in the postoperative period

2. Management

a. Medical therapy with topical, oral, sub-Tenon and intravitreal corticosteroids and topical NSAIDs

E. Endophthalmitis

1. Prevention
    a. Preparation of surgical field with povidone-iodine
    b. Antibiotic prophylaxis
    c. Maintenance of sterile technique
    d. Ensure water tight incisions
2. Management
    a. Recommended treatment per the Endophthalmitis Vitrectomy Study

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Endophthalmitis Vitrectomy Study Group. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol. 1995;113:1479-1496.
3. Results of the Endophthalmitis Vitrectomy Study. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Endophthalmitis Vitrectomy Study Group. Arch Ophthalmol. 1995;21:472-96.

Special cases: sutured posterior chamber intraocular lens implantation

I. List the indications/contraindications

A. Indications

1. When there is inadequate capsular support to stabilize an intraocular lens, whether for the correction of long-standing aphakia or for intraocular lens (IOL) fixation following compromise of the capsule or zonules during surgery

B. Contraindications

1. Same as for IOL implantation in general, i.e., active uncontrolled uveitis
2. Corneal edema or edema on awakening
    a. Corneas at 620-640 microns or greater are at greater risk
3. Scleral inflammation, scleral thinning
4. Significant ocular comorbidities

II. Describe the pre-procedure/therapy evaluation

A. A comprehensive eye examination is required prior to implantation of an IOL

B. Special consideration should be given to concomitant ocular pathology such as glaucoma, uveitis, macular degeneration, peripheral retinal holes or tears and diabetic retinopathy

C. Biometry, keratometry and IOL power calculation are necessary to determine the correct power of the IOL to be implanted

III. List the alternatives to this procedure/therapy

A. Anterior chamber IOL

B. Verisyse (iris claw) IOL

C. Aphakia with contact lens or spectacle correction

IV. Describe the instrumentation, anesthesia and technique

A. Sutured IOLs

1. Iris-sutured
2. May require limited anterior vitrectomy
3. 3-piece lenses most commonly used
4. Several suture techniques have been described including McCannel and Siepser
5. Polypropylene sutures should be used
6. Can be performed under various anesthesia techniques

B. Scleral-sutured

1. May require limited anterior vitrectomy
2. Specialized non-foldable IOLs with haptics containing suture eyelets are most commonly used (e.g. CZ70BD)
3. Can be sutured through scleral flaps, scleral pockets, or scleral incisions

4. Various suture techniques have been described including 4-point and 2-point fixation
5. 9.0 or 8.0 polypropylene sutures should be used. 10.0 sutures should be avoided due to spontaneous post-operative suture rupture
6. Peri-ocular anesthetic blockade is advisable, at a minimum

C. Scleral-glued

1. May require limited anterior vitrectomy
2. Involves direct haptic insertion into the scleral wall
3. Can be placed through scleral flaps, scleral pockets, or scleral incisions
4. Glue is often used to aid in haptic fixation, but may also be used to secure scleral flaps
5. Oversized IOLs with flexible haptics are preferred
6. Peri-ocular anesthetic blockade is advisable, at a minimum

V. List the complications of the procedure/therapy, their prevention and management

A. Subluxation/dislocation/tilting

1. Prevention
   a. Four-point fixation may offer better stability than two-point fixation
   b. Avoid 10-0 suture
2. Management
   a. Repositioning
   b. Resuturing
   c. IOL exchange

B. Uveitis/glaucoma/hyphema

1. Prevention
   a. Secure implantation
2. Management
   a. Medical treatment with anti-inflammatory agents or topical glaucoma medications
   b. IOL repositioning or exchange

C. Pseudophakic bullous keratopathy (corneal decompensation)

1. Prevention
   a. Minimizing surgical trauma
2. Management
   a. Lamellar endothelial keratoplasty
   b. Penetrating keratoplasty

D. Cystoid macular edema

1. Prevention
   a. Use of topical corticosteroid and non-steroidal anti-inflammatory drugs (NSAIDs) in the postoperative period may be protective
2. Management
   a. Medical therapy with topical, oral, sub-Tenon and intravitreal corticosteroids and topical NSAIDs, anti- VEGF treatment

E. Endophthalmitis

1. Prevention

a. Preparation of surgical field with povidone-iodine

b. Antibiotic prophylaxis

c. Maintenance of sterile technique

d. Ensure water tight incision closure

e. Trans-scleral suture may provide a route of entry for bacteria, so construction of scleral flaps or pockets over sutures or rotation of sutures to bury knots under sclera is recommended

2. Management

a. Recommended treatment per the Endophthalmitis Vitrectomy Study

F. Vitreous hemorrhage

G. Retinal detachment

VI. Describe the follow-up care

A. Topical antibiotic and anti-inflammatory agents

B. Examination at 1 day; 2 - 4 weeks

C. Post-operative refraction at 2 - 6 weeks

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Focal Points: IOL Exchanges & Secondary IOLs: Surgical Techniques, Module #1, 1998.

3. Endophthalmitis Vitrectomy Study Group. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol 1995;113:1479-1496.

4. Wagoner M, Cox T, Ariyasu R, et al. Intraocular lens implantation in the absence of capsular support: a report by the American Academy of Ophthalmology.Ophthalmology. 2003;110(4):840-59.,

5. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

6. Por Y, Lavin M. Techniques of intraocular lens suspension in the absence of capsular/zonular support. Surv Ophthalmol. 2005; 50(5):429-62.

Anterior chamber intraocular lens implantation

I. List the indications/contraindications

A. Fixation in the anterior chamber angle is useful when capsular support is inadequate for in-the-bag fixation or sulcus fixation of a posterior chamber intraocular lens (PCIOL)

II. Describe the pre-procedure/therapy evaluation

A. Biometry and keratometry are necessary for IOL power calculation to determine the correct power of the IOL to be implanted

B. Horizontal limbal diameter (white to white) plus 1mm measured manually or using the IOL Master/Lenstar commonly used to determine appropriate sizing of anterior chamber intraocular lens (ACIOL)

C. Preoperative pachymetry and endothelial cell count if ACIOL use is known preoperatively

D. The larger incisions required by ACIOLs usually require suture closure of the incision that may cause postoperative astigmatism

III. List the alternatives to this procedure/therapy

A. Suture fixation of a polymethylmethacrylate (PMMA) or foldable PC IOL, either to the midperipheral or peripheral iris or sclera (1-2mm posterior to the limbus)

B. Sulcus fixation of a three-piece PCIOL

C. Aphakic contact lens

D. Scleral-glued IOL

IV. Describe the instrumentation, anesthesia and technique

A. The incision size must be at least equal to the optic diameter (usually 6mm)

B. A peripheral iridectomy is necessary to avoid pupillary block

C. A lens glide can be used to facilitate insertion and protect the iris

D. ACIOLs are vaulted anteriorly so correct orientation is critical to avoid corneal decompensation and/or pupillary block

E. Peri-ocular anesthetic blockade may be advisable at a minimum

F. Liberal use of viscoelastic is recommended to avoid iris angle incarceration and endothelial protection

V. List the complications of the procedure/therapy, their prevention and management

A. Rigid ACIOL designs are associated with precise sizing requirements and uveitis-glaucoma-hyphema (UGH) syndrome

B. However, modern flexible ACIOLs with open-loop design can be used to achieve excellent results and significantly less chances of causing the UGH syndrome

C. Important complications include:

1. Incorrect sizing of IOL (chronic iritis and endothelial cell loss)
2. Distortion of pupil
3. Iris tuck or capture (chronic iritis and cystoid macular edema)

4. Malposition of IOL
5. Pupillary block
6. Secondary glaucoma
7. Chronic eye pain
8. Corneal edema from inverted ACIOL placement

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. AAO, Ophthalmic Technology Assessment: Intraocular Lens Implantation in the Absence of Capsular Support, Ophthalmology 2003;110:840-859.
4. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.
5. AAO, Focal Points: Sutured Posterior Chamber Intraocular Lenses, Module #9, 2006.

Special cases: secondary intraocular lens implantation

I. List the indications/contraindications

A. Indications

1. When eyeglasses or contact lenses are unsatisfactory for the correction of aphakia

B. Contraindications

1. Same as for intraocular lens (IOL) implantation in general, e.g., active uncontrolled uveitis
2. Corneal edema or edema on awakening
3. Glaucoma with inadequately controlled intraocular pressure
4. Patients with diabetes mellitus at increased risk of macular edema may benefit from preoperative evaluation by a retina subspecialist prior to lens implantation

II. Describe the pre-procedure/therapy evaluation

A. Evaluation of visual potential

B. Evaluation of anterior segment anatomy to determine best incision site and location for secondary IOL should include pachymetry, gonioscopy, and possible specular microscopy as well as consideration of

1. Pre-existing corneal astigmatism
2. Iris and angle anatomy
3. Site of previous surgery (e.g., location of prior clear corneal incisions or filtration procedures)
4. Adequacy of capsular support (i.e., status of capsular bag, anterior capsule/sulcus, zonules, and posterior capsule or lens remnants)
5. Gonioscopy
6. Presence of vitreous in the anterior segment

III. List the alternatives to this procedure/therapy

A. Contact lens wear

B. Spectacle correction

C. Laser vision correction for smaller refractive errors

IV. Describe the instrumentation, anesthesia and technique

A. In-the-bag placement

1. Intact posterior capsule preferable
2. Foldable 3-piece or 1-piece IOLs placement with injector
3. Can be performed under various anesthesia techniques
4. Generous viscoelastic use to maintain intraocular anatomy, protect corneal endothelium, and expand potential spaces

B. Sulcus placement

1. requires adequate anterior capsular support
2. may require limited anterior vitrectomy if open posterior capsule
3. Foldable 3-piece IOL preferred. 1-piece IOLs contraindicated for sulcus placement
4. Can be performed under various anesthesia techniques
5. Generous viscoelastic use to maintain intraocular anatomy, protect corneal endothelium, and expand potential spaces

C. Anterior Chamber IOL (ACIOL)

1. The incision size must be at least equal to the optic diameter (usually 6mm)
2. peripheral iridectomy is necessary to avoid pupillary block
3. A lens glide can be used to facilitate insertion and protect the iris
4. ACIOLs are vaulted anteriorly so correct orientation is critical to avoid corneal decompensation and/or pupillary block
5. Peri-ocular anesthetic blockade may be advisable at a minimum

D. Sutured IOLs

1. Iris-sutured
    a. May require limited anterior vitrectomy
    b. 3-piece lenses most commonly used
    c. Several suture techniques have been described including McCannel and Siepser
    d. Polypropylene sutures should be used
    e. Can be performed under various anesthesia techniques
2. Scleral-sutured
    a. May require limited anterior vitrectomy
    b. specialized non-foldable IOLs with haptics containing suture eyelets are most commonly used (e.g. CZ70BD)
    c. Can be sutured through scleral flaps, scleral pockets, or scleral incisions
    d. Various suture techniques have been described including 4-point and 2-point fixation
    e. 9.0 or 8.0 polypropylene sutures should be used. 10.0 sutures should be avoided due to spontaneous post-operative suture rupture
    f. Peri-ocular anesthetic blockade is advisable, at a minimum

E. Scleral-glued

1. May require limited anterior vitrectomy
2. Involves direct haptic insertion into the scleral wall
3. Can be placed through scleral flaps, scleral pockets, or scleral incisions
4. Glue is often used to aid in haptic fixation, but may also be used to secure scleral flaps
5. Oversized IOLs with flexible haptics are preferred
6. Peri-ocular anesthetic blockade is advisable, at a minimum

V. List the complications of the procedure/therapy, their prevention and management

A. Subluxation/dislocation/IOL tilt

1. Prevention
    a. Secure location, with suture if necessary
    b. Four-point fixation may offer better stability than two-point fixation

i. Use thicker suture gauge than 10-0

2. Management

a. Suture fixation (iris, sclera)

b. IOL repositioning

c. IOL exchange

d. ACIOL placement

B. Uveitis/glaucoma/hyphema

1. Prevention

a. Secure implantation (early, rigid ACIOL) designs were associated with precise sizing requirements and uveitis-glaucoma-hyphema syndrome

b. However, modern flexible anterior chamber lenses with open-loop design and footplates free of fixation holes can be used to achieve excellent results in selected cases

2. Management

a. Medical treatment with anti-inflammatory agents

b. Topical glaucoma medications

c. IOL repositioning or exchange

C. Pseudophakic corneal edema

1. Prevention

a. Minimizing surgical trauma

b. Ensure ACIOLs are not placed upside down

c. Liberal use of viscoelastic to maintain potential space

2. Management

a. Lamellar endothelial keratoplasty

b. Penetrating keratoplasty

D. Cystoid macular edema

1. Prevention

a. Use of topical corticosteroids and NSAIDs in the postoperative period may be protective

2. Management

a. Medical therapy with topical, oral, sub-Tenon and intravitreal corticosteroids and topical NSAIDs, intravitreal ant-VEGF agents

E. Endophthalmitis - incidence is greater than for primary cataract surgery

F. Vitreous hemorrhage

G. Retinal detachment

H. Distortion of pupil

1. Seen with ACIOL haptic incarceration of peripheral iris

2. Seen with iris-sutures placed too close to pupil

VI. Describe the follow-up care

A. Same as for IOL implantation in general (See Intraocular lens material and design)

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Endophthalmitis Vitrectomy Study Group. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol. 1995;113:1479-1496.

3. Results of the Endophthalmitis Vitrectomy Study. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Endophthalmitis Vitrectomy Study Group. Arch Ophthalmol. 1995;21:472-96.

Intraocular lens implantation in children

I. List the indications/contraindications

A. Indication is for correction of aphakia after cataract surgery

B. Commonly recommended for advanced bilateral cataracts when surgery is needed- ideally, before 3 months of age (studies suggest improved binocularity). Considerations include

1. Age of patient
    a. Not well established for patients less than 2 years of age
2. Growth of the eye
3. Change in refractive error over time
4. More elastic capsule
5. Less scleral rigidity
6. Risk of amblyopia
7. Increased inflammatory response

C. Relative contraindication includes eyes with

1. Sclerocornea
2. Microphthalmos
3. Corneal endothelial dystrophy
4. Rubella cataract
5. Uveitis

II. Describe the pre-procedure/therapy evaluation

A. Intraocular lenses (IOLs) are not approved by the Food and Drug Administration (FDA) for implantation in children

1. Mechanisms recognized for implantation include:
    a. Investigational device exemption (IDE)
    b. Waiver of age indication (adult IDE requires approval of Institutional Review Board)
    c. Off-label use under the good medical practice rule (most common method)

B. Biometry, keratometry and IOL power calculation are necessary to determine the correct power of the IOL to be implanted

1. These may be performed under general anesthesia
2. The target refraction must take into account the typical myopic shift which occurs with growth as well as postoperative anisometropia

C. The ideal IOL power for a given patient can be difficult to determine

III. List the alternatives to this procedure/therapy

A. Aphakia, contact lens, or eyeglass correction

IV. Describe the instrumentation, anesthesia and technique

A. IOL

1. Posterior chamber IOLs are preferred
2. Capsular bag or "in the bag" technique with or without posterior optic capture is the desired technique
3. Sulcus fixation can be successful. Anterior chamber intraocular lens (ACIOL) is generally not recommended

B. Incision

1. Clear corneal incisions and scleral tunnel incision often require suture closure due to less rigid structure of pediatric eye (reduced scleral rigidity)

C. Capsulorrhexis

1. Technically difficult due to greater elasticity of capsule and tendency for the capsulorrhexis to expand to the periphery of the lens
2. High molecular weight ophthalmic viscosurgical device (OVD) (viscoelastic) with high zero shear viscosity may be helpful
3. Alternatives to performing a continuous tear capsulorrhexis include vitrectorhexis, performed with a mechanized vitreous cutter and use of plasma knife (Fugo blade) or diathermy
4. Consider the use of Trypan blue to make the capsular tear easier to control

D. Lens extraction

1. Generally, the pediatric cataractous lens is much softer than the adult cataract and may be extracted using aspiration and irrigation alone, without ultrasonic phacoemulsification

E. Management of posterior capsule

1. Rapid opacification develops in pediatric eyes and increases the risk of amblyopia
2. Primary posterior capsulorrhexis or capsulotomy is indicated in children unable to cooperate with neodymium yttrium-aluminum-garnet (Nd: YAG) laser capsulotomy (less than 4 - 6 years of age)
3. Results improve with limited vitrectomy
4. The IOL optic may be captured posterior to the posterior capsule with the haptics in the bag

F. General anesthesia is required for cataract surgery in children.

V. List the complications of the procedure/therapy, their prevention and management

A. Inflammation

1. Atropine cycloplegia maintained for one month
2. Aggressive use of topical corticosteroids
3. Systemic corticosteroids may be considered

B. Glaucoma

1. Monitoring of intraocular pressure
2. Use of topical or oral medications as necessary

C. Amblyopia

1. Early refraction (with exam under anesthesia, if necessary)
2. Contact lens or eyeglass prescription
3. Therapy with patching or penalization

VI. Describe the follow-up care

A. Patients are seen frequently in the postoperative period and during amblyopia therapy

VII. Describe appropriate patient instructions

A. Parents are instructed in proper administration of eye drops, ointment, contact lens, eyeglasses and/or occlusive patch

B. Stress compliance with medications and postoperative visits

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. Wilson ME. Management of aphakia in children. In: Focal Points: Clinical Modules for Ophthalmologists. San Francisco: American Academy of Ophthalmology; 1999: vol 17, no 1.
4. Wilson ME, Apple DJ, Bluestein EC, et al. Intraocular lenses for pediatric implantation: biomaterials, designs, and sizing. J Cataract Refract Surg 1994;20:584-591.
5. Wilson ME, Bluestein EC, Wang XH. Current trends in the use of intraocular lenses in children. J Cataract Refract Surg 1994;20:579-583.
6. Trivedi RH, Peterseim NM, Wilson ME Jr. New techniques and technology for pediatric cataract surgery. Curr Opin Ophthalmol 2005;16:289-93.
7. Zetterstrom C, Lundvall A, Kugelberg M. Cataracts in children. J Cataract Refract Surg 2005;31:824-40.
8. AAO, Focal Points: Sutured Posterior Chamber Intraocular Lenses, Module #9, 2006.

Presbyopia-correcting intraocular lenses (IOLs)

I. List the indications and contraindications

A. Terms and definitions

1. Presbyopia-correcting intraocular lenses are designed to reduce or eliminate dependence on spectacles after cataract surgery, and may be divided into two broad categories
    a. Multifocal IOLs
    b. Accommodating IOLs

B. Indications

1. A presbyopia-correcting IOL is indicated for implantation in the capsular bag of the eye for the visual correction of aphakia
2. Also intended to reduce or eliminate the need for optical correction for near, intermediate, and distance vision

C. Contraindications

1. Patients achieve the most satisfactory results from presbyopia correcting IOLs when they achieve excellent unaided distance vision.
    a. Ophthalmic conditions, which reduce the potential for good uncorrected vision, represent at the very least relative contraindications. These include abnormalities of macular function such as:
        i. Significant epiretinal membrane
        ii. Age-related macular degeneration
        iii. Macular edema
2. Other relative contraindications
    a. Irregular astigmatism
    b. Significant field loss from conditions such as glaucoma or optic neuropathy
    c. Corneal edema or significant endothelial corneal dystrophy
    d. Anterior corneal dystrophy (e.g. anterior basement membrane dystrophy)
    e. Unrealistic expectations
    f. Significant dry eye
    g. Cases with unreliable biometry
3. Multifocal IOLs may be contraindicated in patients with occupational night driving needs because of the potential for glare and halo

II. Describe the pre-procedure evaluation

A. Education of the patient regarding risks, benefits and appropriate expectations regarding the presbyopia correcting IOL to be utilized

B. Accurate biometry, keratometry and IOL power calculation are necessary to determine the correct power of the IOL to be implanted

C. Evaluation of macular function may include one or more of the following:

1. Slit lamp biomicroscopy
2. Tests of potential visual acuity
3. Optical coherence tomography

4. Fluorescein angiography; retina consultation

D. Patients with pre-existing astigmatism require corneal topography to aid in the evaluation and planning of any adjunctive astigmatic procedures

E. Because significant dry eye syndrome and ocular surface disease can compromise the function of these IOLs these conditions should be treated aggressively

III. List the alternatives to this procedure

A. Cataract surgery with a monofocal IOL with postoperative spectacle or contact lens use

B. Cataract surgery with planned monovision

IV. Describe the instrumentation, anesthesia and technique

A. The IOL is injected into the capsular bag with an injector system specific to the particular platform utilized. Each manufacturer has a recommendation regarding the appropriate sized capsulorrhexis

B. The accommodating IOL is designed only for capsular bag implantation both to achieve the appropriate vault and position within the eye and also to allow for any achieved accommodative effect

C. Three piece full optic diffractive, apodized diffractive and zonal refractive multifocal IOLs can be placed, if necessary, within the ciliary sulcus as an off-label procedure

1. Optic capture through the capsulorrhexis should be performed to ensure centration

D. Coexisting astigmatism can be managed with a keratorefractive procedure such as limbal relaxing incision (LRI), astigmatic keratotomy or laser vision correction (LVC) following the cataract surgery

E. Anesthesia: topical, intracameral, peribulbar, retrobulbar, general

V. List the complications of the procedure, their prevention and management

A. Residual refractive error can compromise the visual function achieved with presbyopia-correcting IOLs

B. Postoperative astigmatic refractive errors can be treated with limbal relaxing incisions or laser vision correction (LVC)

C. Significant spherical errors can be treated with IOL exchange or LVC

D. Patients may still require spectacles for some visual activities and should be counseled preoperatively regarding this possibility

E. Patients with multifocal IOLs may have glare and halo symptoms with night driving

1. Depending on the IOL platform these symptoms may improve with pharmacologic manipulation of the pupil
2. In rare instances patients may require IOL exchange if these symptoms are severe
3. Over time these symptoms may improve without intervention

VI. Describe the follow-up care

A. Topical antibiotic and anti-inflammatory agents

B. Examination at 1 day; 2 - 4 weeks

C. Post-operative refraction at 2 - 6 weeks

D. Observe for posterior capsule opacification. Patients with presbyopic IOLs can have reduced visual function especially at near, which may improve with Nd: YAG laser capsulotomy

Additional Resources

1. CMS Rulings, Department of Health and Human Services, Centers for Medicare & Medicaid Services. Ruling No. 05-01 May 3, 2005.

2. Mastering Refractive IOLs: The art and science. Edited by David F. Chang, 960 pages, 2008, Slack Incorporated.

Intraoperative shallowing of the anterior chamber

I. Describe the intraoperative appearance of a ‘normal' depth anterior chamber

A. Iris diaphragm typically flat

1. With long axial lengths, iris may appear concave unless irrigation bottle lowered or pupil margin elevated
2. With short axial lengths, iris may appear convex unless irrigation bottle raised

B. Adequate room for instrumentation, i.e. phaco tip, second instrument

C. Anterior chamber easily holds air, fluid or ophthalmic viscosurgical device (OVD)

II. List general categories of problems that can cause difficulty maintaining the anterior chamber and describe what you would expect to observe in each

A. Incorrect fluidics

1. Inadequate irrigation inflow
    a. No deepening of chamber noted when irrigation flowing
    b. Raising the irrigation bottle causes chamber to deepen
    c. Corneal dome may indent when aspiration engaged
    d. Pupil size may vary when aspiration engaged
    e. Excessive aspiration
    f. Pupil size varies when aspiration engaged and disengaged
    g. Sudden shallowing when phaco tip occlusion breaks (surge)

B. Incision too large for size of ultrasound tip

1. Excessive outflow through incision
2. Deepening of chamber when incision size made smaller by holding with forceps or suture
3. Iris prolapse

C. External pressure

1. Shallowed chamber reducing available work space
2. Anterior chamber will not hold fluid, air or OVD
3. Raising irrigation bottle has no helpful effect
4. Iris may prolapse
5. May have peripheral extension during anterior capsulorrhexis

D. Internal pressure

1. Shallowed chamber reducing available work space
2. Anterior chamber will not hold fluid, air or OVD
3. Raising irrigation bottle has no helpful effect
4. Iris may prolapse
5. May have peripheral extension during anterior capsulorrhexis

III. Describe possible external causes

A. Irrigation tubing incorrectly assembled, connected or kinked

B. Irrigation bottle too low or empty

C. Irrigation less than aspiration flow rate

D. Lid squeezing, tight fissure

E. Pressure from speculum, drape

F. Retrobulbar hemorrhage

IV. Describe possible sources of internal pressure

A. Irrigation fluid misdirected posteriorly

B. Suprachoroidal effusion/hemorrhage

V. Describe how you would distinguish between external and internal causes of anterior chamber shallowing

A. Palpate globe after all instruments removed

1. External causes - globe is soft
2. Internal causes - globe is firm

B. Assess red reflex if possible

C. Indirect ophthalmoscopy

VI. Describe the risk factors that might predispose to chamber shallowing from an internal cause

A. Prolonged operating time

B. Arteriosclerotic heart disease

C. Pre-existing glaucoma

D. Increased age

E. Increased IV/ thoracic pressure

F. Patient positioned with head lower than heart

G. Nanophthalmia

VII. Describe your intraoperative management when confronted with the problem of chamber maintenance

A. Raise irrigation bottle, if not adequate then:

B. Palpate globe with irrigation off

1. If globe soft, run through check list of above external causes of incorrect incision and fluidics
2. If globe seems firm, remove instruments and palpate globe again

C. If globe still firm, see if chamber will hold air or OVD

1. If yes, attempt to insert phaco tip to complete surgery
2. If yes, but cannot insert tip, consider limited pars plana vitrectomy recognizing its associated risks, once you have ruled out the possibility of suprachoroidal effusion/hemorrhage
3. If no, stop surgery and close eye with a suture

D. Check pressure in post op holding area at intervals to see if globe softens

1. If softens, return to operating room (OR) to finish case later that day
2. If globe remains firm, initiate ocular anti-hypertensive treatment and monitor pressure until normalized, then return to OR

VIII. Describe what you would expect to encounter postoperatively in the event you had to stop surgery before the cataract extraction was complete

A. Increased intraocular pressure

B. Increased inflammation

C. Some corneal edema (which may have a temporary effect on vision or may require keratoplasty if edema fails to resolve)

D. The need for more frequent postoperative examinations

E. Patient concerns which require handling in a personal, friendly, reassuring manner

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Incisional thermal injury or "phaco burn"

I. Describe the source of heat generation and its dissipation during phacoemulsification

A. Frictional forces created by ultrasonic tip vibration causes heating of the phaco needle

B. Cooling of the phaco needle is by dissipation of heat as a result of fluid flow around and through the tip during surgery

C. Reduced tip heat production associated with modulation of phacoemulsification energy

II. Describe what a thermal injury or 'phaco burn' appears like intraoperatively

A. Pre-burn - note appearance of non-aspirated lens emulsion ('lens milk')

B. Mild

1. Increased rigidity of tissue
2. Corneal epithelium sloughs at incision site
3. Incision edges may gape slightly instead of being self-closing

C. Moderate

1. White appearance to incisional tissues
2. Tissue shrinkage at incision edges may prevent self-closure

D. Severe

1. Whitened, friable and absent tissue
2. Much tissue shrinkage distorting incision edges giving incision gape to full thickness defect often with associated corneal striae

III. Describe what things may contribute to a thermal injury

A. Inadequate cooling around phaco tip

1. Tight incision compressing infusion sleeve
2. Irrigation bottle too low or empty
3. Irrigation tubing kinked, compressed or improperly assembled
4. Excessive handpiece torquing of the phaco tip in the wound resulting in kinking or compression of irrigation sleeve
5. Unrecognized loss of irrigation tubing from phaco handpiece

B. Poor aspiration fluid flow through phaco tip

1. Inadequate vacuum level
2. Clogged or crimped aspiration tubing
3. Plugged tip or tubing, with lens material

C. Prolonged continuous use of ultrasound power

IV. Describe techniques, maneuvers or instrumentation that might reduce the chances of thermal injury during phacoemulsification

A. Test irrigation prior to insertion of phaco tip and verify tight irrigation tubing connection to phaco handpiece

B. Aspiration of some OVD upon phaco tip entry into anterior chamber prior to engaging ultrasound power

C. Ensure incision size adequate for phaco tip

D. Adjust phacoemulsification machine settings based on technique and lens density

E. Consider performing maneuvers that fragment the nucleus to reduce the amount of necessary phaco power

F. Consider using power modulations with short bursts of ultrasound power or burst or pulse modes

G. Consider continual outside irrigation to incision site

H. Clouding of aqueous around the phaco tip (white, milky appearance) can be a sign of heat generation and if encountered, disengage phaco power immediately and determine cause

1. Often aspirating viscoelastic at a higher vacuum setting for a brief moment will clear the tip and allow safe continuation of the procedure

V. Describe the intraoperative management of a phaco induced thermal injury

A. Mild - nothing if incision is still self-closing

B. Moderate - suture closure

C. Severe - suture plus patch graft of conjunctiva or sclera, partial thickness flap or relaxing incision. Cyanoacrylate glue or other tissue sealant may also be used to ensure wound closure

VI. Describe the postoperative follow up care

A. Evaluate for wound leak (Seidel testing) during the first week

1. For persistent wound leak consider contact lens, aqueous suppressants, wound revision, glue or patch graft

B. Expect high astigmatism which may regress gradually

C. High astigmatism may require corneal relaxing incision

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Detachment of Descemet membrane

I. Describe the immediate intraoperative appearance of a torn and of a detached Descemet membrane

A. May be torn but attached with free edge rolled upon itself

B. May appear as a free floating scroll similar to an anterior capsular remnant

C. May be completely detached centrally but remain attached peripherally

II. Describe the etiology of this complication

A. Edge of Descemet membrane may be caught at incision by instrument or intraocular lens (IOL)

1. Usually results in either free flap or torn strip

B. During injection of ophthalmic viscosurgical device (viscoelastic)

1. May occur at side port paracentesis or incision site if cannula not completely inserted into anterior chamber
2. May result in partial or, if unrecognized during injection, a complete detachment of Descemet membrane

C. Injection of fluid for hydration of incision or side port may detach Descemet membrane if cannula placed too far posteriorly into stroma; usually results in partial detachment as volume used is small

III. If left untreated, describe the effects of a detachment of Descemet membrane

A. If small area involved, may have transient localized overlying microcystic edema. These may resolve spontaneously

B. Larger area may have persistent epithelial and stromal edema unless the area involved can re-endothelialize over time, resulting in clearing of the associated edema

C. If the involved area is large enough or endothelial cell density low enough, resulting in persistent corneal edema, the patient may need endothelial or penetrating keratoplasty

IV. Describe treatment options and postoperative instructions

A. Observation with supportive care (hypertensive saline drops) is appropriate for the first few months post-operatively

B. Small free floating scroll should be removed to avoid further damage to the corneal endothelium

C. A large (enough to cause symptoms) attached torn flap can be repositioned with air or other expansile gas (SF6 or C3F8) placed in anterior chamber; with head in proper position so that bubble tamponades flap

1. Overfilling (>50% of anterior chamber) with expansile gas can increase intraocular pressure and cause pupillary block

D. Sutures to tack Descemet membrane may be useful

E. Endothelial or penetrating keratoplasty may eventually be necessary if corneal edema is persistent

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.54-55.

Toxic anterior segment syndrome (TASS)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Potential intraoperative sources for toxic substances that may result in TASS
    a. Irrigating solutions and ophthalmic viscosurgical devices
        i. Incorrect chemical composition
        ii. Incorrect pH (<6.5 or >8.5)
        iii. Incorrect osmolality (<200 mOsm or >400 mOsm)
        iv. Preservatives or additives (e.g., antibiotics, diluting medications)
    b. Ophthalmic instrument contaminants
        i. Detergent residues (ultrasonic, soaps, enzymatic cleaners)
        ii. Bacterial lipopolysaccharides or other endotoxin residue
        iii. Metal ion residue (copper and iron)
        iv. Denatured OVD
    c. Ocular medications
        i. Incorrect drug concentration
        ii. Incorrect pH (<6.5 or > 8.5)
        iii. Incorrect osmolality (<200 mOsm or >400 mOsm)
        iv. Vehicle with wrong pH or osmolality
        v. Preservative in medication solution (e.g., bisulfites in epinephrine)
    d. Intraocular lenses (IOLs)
        i. Polishing compounds
        ii. Cleaning and sterilizing compounds (e.g., chlorhexidine gluconate)
    e. Skin cleaners containing chlorhexidine gluconate

B. Define the relevant aspects of epidemiology of the disease

1. Patients undergoing cataract or anterior segment surgery often representing an endemic outbreak at a specific surgical center

C. List the pertinent elements of the history

1. Typically occurs in the first 12-24 hours (vs 2-7 days for bacterial endophthalmitis)
2. Almost always limited to anterior segment
3. Improves with topical corticosteroids
4. Commonly presents with diffuse corneal edema
5. Blurry vision, eye pain, eye redness, photophobia

D. Describe pertinent clinical features

1. Intraoperative and postoperative corneal appearance after a toxic substance has been injected into the anterior chamber
    a. Intraoperatively
        i. No effect or

ii. Ground glass-like haze at endothelial level

b. Postoperatively

i. Folds in Descemet membrane

ii. Corneal edema (limbus to limbus)

iii. Variable intraocular pressure (IOP) elevation due to trabecular meshwork damage

iv. Iris damage, possible pupil dysfunction

v. Cystoid macular edema

vi. Sterile anterior segment inflammation with possible hypopyon

vii. Fibrin formation in anterior chamber or on IOL or iris

viii. Relative lack of vitreous cell or inflammation compared to anterior chamber

2. Compare and contrast the appearance of corneal edema from mechanical trauma and that from a toxic agent

a. Mechanical trauma typically involves a localized area, often the central cornea with sparing of the periphery, but localized segmental peripheral edema may also result from mechanical trauma.

b. Toxic agent diffusely involves both the central and the peripheral cornea

II. List the differential diagnosis

A. Causes of postoperative corneal edema

1. Mechanical trauma
2. Toxic agent/substance
3. Pre-existing endothelial compromise, e.g., Fuchs endothelial dystrophy
4. Excessive use of ultrasound energy
5. Descemet detachment

B. Infectious endophthalmitis

C. Uveitis flare-up

III. Describe patient management in terms of treatment and follow-up

A. Intraoperative and postoperative management for corneal damage from a toxic agent (Main treatment of TASS centers on prevention)

1. Intraoperative (Immediate recognition of toxic agent)

a. Irrigate anterior chamber with balanced salt solution to wash out all the toxic agent

b. Refill anterior chamber at conclusion of procedure with BSS

c. Subconjunctival corticosteroid injection

2. Postoperatively managing from slight to progressively more severe inflammatory reaction

a. Have a low threshold for vitreous and/or anterior chamber culture with injection of antibiotics if infection is suspected

b. Mainstay is frequent topical corticosteroid drops

i. Frequent follow-up necessary to gauge response

c. Lower IOP with aqueous suppressant drops if elevated

d. Sub-Tenons injection of corticosteroid if needed to control inflammation

e. Intravitreal corticosteroid injection if needed to control inflammation

f. Systemic corticosteroids if needed to control inflammation

i. Prednisone -rapid taper

ii. Side effects

g. Penetrating keratoplasty or endothelial keratoplasty may be required to restore vision if corneal edema is not reversible

h. Gonioscopic evaluation for peripheral anterior synechia (PAS)

i. Specular or confocal microscopy for endothelial evaluation

IV. List the complications of treatment, their prevention and management

A. Complications of topical, sub-Tenon corticosteroids include ocular hypertension, and with intracameral or intraocular injections, include the risk of infectious endophthalmitis

1. Monitor IOP during and after treatment

B. Review of protocol for cleaning and sterilizing ophthalmic instruments

C. Review of protocol for ordering medications and preparing medications

D. Reusable instruments should be kept to a minimum and should be cleaned with sterile, deionized water

V. Describe disease-related complications

A. Loss of vision

B. Endothelial cell loss resulting in bullous keratopathy

C. Secondary glaucoma due to PAS and trabecular meshwork damage

D. Iris damage with fixed, dilated pupil

E. Cystoid macular edema

VI. Describe appropriate patient instructions

A. Frequent visits in the immediate postoperative period

1. Monitor inflammation, IOP, corneal edema, vision

B. Long-term evaluation of cornea, IOP and vision

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.60.

3. Mamalis N, Edelhauser HF, Dawson DG.et al.Toxic Anterior Segment Syndrome Review/Update. J Cataract Refract Surg 2006; 32:324-333.

Retrobulbar hemorrhage

I. Describe the mechanism of a retrobulbar hemorrhage and vision loss

A. Puncture or tearing of orbital blood vessel

B. Bleeding in an enclosed area (orbit) raises orbital pressure which raises intraocular pressure

C. This compartment syndrome may restrict vascular supply to the optic nerve and globe, resulting in central retinal vein and/or artery compromise or compressive/ischemic optic neuropathy

D. May have direct injury to optic nerve or compression of the nerve in the optic canal

II. Describe the clinical features of a retrobulbar hemorrhage

A. Increasing proptosis

B. Lid ecchymosis

C. Reduced motility

D. Unable to displace globe posteriorly or separate lids

E. Elevated IOP

F. Subconjunctival hemorrhage

III. Describe the adverse sequelae that can result from a retrobulbar hemorrhage

A. If surgery in progress, may note increased posterior pressure with loss of chamber, iris prolapse, etc.

B. Loss of vision

1. Optic nerve compression and ischemic optic neuropathy
2. Central retinal artery or vein occlusion

C. Optic atrophy from optic nerve compression

D. Diplopia

IV. Describe patient management in this situation

A. If occurs preoperatively, cancel surgery unless hemorrhage is minor/limited

B. If occurs intraoperatively, stop surgery and close incision temporarily if posterior pressure is progressive

C. Serial tonometry should be performed to monitor treatment success

D. Treatment is aimed at rapidly lowering orbital and intraocular pressure

1. Digital massage if globe is intact
2. Aqueous suppressants
3. IV osmotic agents
4. Lateral canthotomy and cantholysis
5. Conjunctival peritomy
6. Paracentesis

V. Describe alternative anesthetic approaches to a retrobulbar injection

A. Topical/intracameral

B. Peribulbar/sub-Tenon injection

C. General anesthesia

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.51-52.
3. Cionni R, Osher R. Retrobulbar hemorrhage. Ophthalmology. 1991;98:1153-1155.

Suprachoroidal hemorrhage

I. Describe the probable mechanism of a suprachoroidal hemorrhage

A. **Source of hemorrhage likely a sclerotic vessel that crosses the suprachoroidal space**

B. **Rapid decompression of the eye or prolonged hypotony during ocular surgery leads to effusion from choroid which stretches and breaks bridging blood vessels**

II. Describe the risk factors associated with suprachoroidal hemorrhage

A. **Increased age**

B. **History of glaucoma**

C. **Axial length >25.8 mm**

D. **Intraoperative pulse > 85 per min.**

E. **Long operative time with prolonged intraoperative ocular hypotony**

F. **Hypertension (systemic)**

G. **Arteriosclerotic heart disease**

H. **Preoperative intraocular pressure (IOP) > 18 mm Hg**

I. **Drugs which affect coagulation**

J. **Nanophthalmos**

K. **Chronic ocular inflammation**

L. **Sturge-Weber associated choroidal hemangioma**

III. Describe the intraoperative signs of an evolving suprachoroidal hemorrhage

A. **Firm eye with associated patient agitation and pain**

B. **Increased posterior pressure with shallowing of anterior chamber**

C. **Iris prolapse**

D. **Loss of red reflex or increasing shadow appearing in red reflex**

E. **Wound gape**

F. **Spontaneous delivery of the lens**

G. **Expulsion of intraocular contents**

IV. Describe the appropriate intraoperative management for suprachoroidal hemorrhage

A. **Surgical**

1. Immediate closure of incision once hemorrhages recognized. If not self-sealing, use sutures. If sutures not immediately available, direct pressure on incision until they are
2. If can't close incision, consider posterior sclerotomy in area of shadow
3. Return to complete operation after hemorrhage has stopped and IOP has become normal
4. Consider referral to vitreoretinal surgeon for consultation regarding management

V. Describe the surgical plan for a patient who is high risk for choroidal hemorrhage

A. Aggressive IOP control preoperatively

B. Aggressive blood pressure control preoperatively

C. Control blood pressure intraoperatively

D. Position in reverse Trendelenburg so eye is higher than heart

E. Small incision surgery

F. Pre-placed sutures if incision > 6 mm

G. Minimize operating time

H. Avoid ocular hypotony and shallow anterior chamber during surgery

1. Consider separate continuous anterior chamber infusion port to prevent hypotony following removal of phacoemulsification needle/infusion during procedure steps

I. Avoid rapid decompression of the eye

J. Discontinue anticoagulants preoperatively after medical consultation

K. If IOP >35 mmHg preoperatively, use intravenous (IV) mannitol 1 g/kg over 30 to 60 min. or 250mg/kg IV push

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Focal Points: The Torn Posterior Capsule: Prevention, Recognition and Management, Module #4, 1999, p.5.

Surgical trauma - hyphema

I. List the anterior segment structures of a normal eye that might be sources for possible hemorrhage

- **A.** Iris pupillary margin vessels
- **B.** Iris stromal vessels
- **C.** Major arterial circle at iris root
- **D.** Ciliary body vessels of intramuscular circle
- **E.** Incision related vasculature (limbal vasculature)

II. List the risk factors for hemorrhage

- **A.** IFIS
- **B.** Uveitis
- **C.** Iris neovascularization
- **D.** Fuchs heterochromic iridocyclitis
- **E.** Iris manipulation
- **F.** Anticoagulation

III. Describe the possible postoperative consequences from a surgical hyphema

- **A.** Decreased vision
- **B.** Increased intraocular pressure secondary to mechanical obstruction of trabecular meshwork by red blood cells with secondary glaucoma
- **C.** Corneal blood staining
- **D.** Chronic inflammation
- **E.** Peripheral anterior synechiae and posterior synechiae
- **F.** Diffusion of blood into vitreous

IV. Describe intraoperative options for management of bleeding

- **A.** Temporarily pressurize the globe
- **B.** Ophthalmic viscosurgical device (viscoelastic) injection into anterior chamber to tamponade bleeding site (See Ophthalmic viscosurgical devices)
- **C.** Wet field cautery (to source of bleeding)
- **D.** Photocoagulation with endoscopic laser if available
- **E.** Endodiathermy if available
- **F.** Intracameral air
- **G.** Intracameral dilute preservative free epinephrine or phenylephrine

V. Postoperative management of hyphema

- **A.** Bedrest

B. Cycloplegia

C. Protective Eye Shield

D. Adequate monitoring and control of IOP

E. Adequate monitoring and control of inflammation

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Crouch ER Jr, Frenkel M: Aminocaproic acid in the treatment of traumatic hyphema. AM J Ophth 81:355, 1976
3. Read JE: Traumatic hyphema: Comparison of medical and surgical treatment for traumatic hyphema. Ann Ophth 7:659, 1975
4. Leet DM: Treatment of total hyphemas with urokinase. Am J Ophth 84:79, 1977
5. Michels RG, Rice TA: Bimanual bipolar diathermy for treatment of bleeding from the anterior chamber angle. Am J Ophth 84:873, 1977
6. Fine IH, Hoffman RS, Packer M. Bimanual bipolar diathermy for recurrent hyphema after anterior segment intraocular surgery. J Cataract Refract Surg. 2004 Sep;30(9):2017-20.

Microscope induced light toxicity

I. Describe the nature of the injury that can be associated with the light microscope

A. Photochemical damage to retina and retinal pigment epithelial layers from unfiltered blue and near ultraviolet radiation

II. Describe factors that contribute to the potential for damage and how each may be addressed

A. Prolonged operating time

1. Reduce operating time
2. Use oblique lighting
3. Use a pupillary shield, especially in phakic or pseudophakic state

B. High light intensity

C. Reduce light level to only that required for safe view

1. Use oblique lighting
2. Use pupillary shield
3. Use a filter to exclude light below 515nm

III. Describe the symptoms and signs of retinal photic injury and how might you investigate

A. The majority of injuries produce minimal symptoms

B. Paracentral scotoma and permanent central vision loss may occur

C. Clinical findings are not evident immediately

D. Retinal edema and mild pigmentary changes, a mild yellow-white discoloration of the retina within one to two days

E. Varying degrees of pigmentary mottling after 1 to 3 weeks

F. Autofluorescence photography is useful in demonstrating changes which may not be visible clinically

G. Intravenous (IV) fluorescein angiography shows a sharply circumscribed area of hyperfluorescence surrounding area of hypo-fluorescence

H. Prognosis depends upon retinal location and intensity and duration of exposure and may range from no visual loss to severe loss

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. FDA Public Health Advisory: Retinal Photic Injuries from operating microscopes during cataract surgery. October 16, 1995.
3. Michael R, Wegener A. Estimation of safe exposure time from an ophthalmic operating microscope with regard to ultraviolet radiation and blue-light hazards to the eye. J Opt Soc Am A Opt Image Sci Vis. 2004 Aug;21(8):1388-92.

Postoperative elevated intraocular pressure

I. List possible causal mechanisms for elevated intraocular pressure following cataract surgery

A. Open Angle

1. Residual ophthalmic viscosurgical device (OVD)
2. Inflammation of trabecular meshwork (e.g. uveitis)
3. Retained lens material
4. Hyphema
5. Pigment dispersion
6. TASS
7. Endophthalmitis
8. Preexisting glaucoma
9. Vitreous in anterior chamber

B. Closed angle

1. Mechanical pupillary block (e.g. anterior chamber intraocular lens without peripheral iridectomy)
2. Peripheral anterior synechiae
3. Neovascular glaucoma

C. Aqueous misdirection

D. Patients at risk for or currently being treated for glaucoma may be at increased risk for post-operative pressure spikes

II. Describe the approach to establishing the diagnosis of increased intraocular pressure

A. Patient symptoms - frequently not present even with higher pressures

1. Pain in and around eye
2. Headache
3. Foggy vision
4. Gastrointestinal symptoms (vagal stimulation)

B. Observe cornea for epithelial edema/steamy corneal appearance

C. Measure intraocular pressure (IOP)

III. Describe the management in terms of intraoperative and postoperative treatment and follow-up

A. Remove all OVD intraoperatively

B. Side port decompression of anterior chamber at slit-lamp biomicroscope

C. Short term ocular hypotensive agents (IOP tends to spike at 4-6 hours and is short-lived, typically lasting 1-2 days)

1. Oral, IV, or topical carbonic anhydrase inhibitors

2. Topical beta-adrenergic antagonists

3. Topical alpha-2 adrenergic agonists

4. Intracameral carbachol

D. Laser peripheral iridotomy if pupillary block present

IV. List the complications of treatment and describe how they might be prevented

A. Endophthalmitis from side-port decompression

1. Topical antimicrobials drops prior to decompression

2. Do not reduce IOP below that needed to maintain self-sealing of incision

B. Drug reaction

1. Heart/lung response to beta-adrenergic antagonists

2. Sulfa allergy, reaction to acetazolamide, etc.

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 60.

3. AAO, Focal Points: Evaluation of Impaired Visual Acuity Following Cataract Surgery, Module #6, 1996, p.4-5.

Intraoperative signs of posterior capsular rupture

I. List reasons why a posterior capsule might be ruptured intraoperatively

A. Intraoperative occurrences

1. Excessive hydrodissection of lens without allowing fluid egress
2. Unrecovered errant continuous curvilinear capsulorrhexis to periphery which extends posteriorly
3. Broken by surgical instrument
4. Surge in aspiration line after occlusion break during phacoemulsification (post-occlusion surge) drawing capsule into phaco tip
5. During removal of cortex or capsular polish, capsule inadvertently aspirated into aspiration port and tip moved prior to release of capsule
6. Delivering the intraocular lens into the capsular bag

B. Defective capsule

1. Posterior lenticonus
2. Posterior polar cataract
3. Inadvertent damage to posterior capsule from prior pars plana vitrectomy or intravitreal injection
4. Penetrating trauma

C. Intumescent lens whose internal pressure extends initial capsulorrhexis tear

II. Describe the changes you would observe in the behavior of the anterior chamber structures if the posterior capsule is broken

A. Anterior chamber (AC) deepens

B. Pupil appears to widen

C. Iris may appear concave

D. Lens particles may disappear posteriorly instead of circulating in AC

E. Lens nucleus may displace/descend rather than returning to central position

F. Vitreous may move anteriorly into AC and obstruct aspiration port of hand piece or entrap lens particles, leading to poor followability of endonuclear fragments

G. Nucleus may become difficult to spin

H. OVD falls into the vitreous cavity

I. IOL is decentered, tilted or appears to be falling into the vitreous cavity

III. Describe your management goals when faced with an open posterior capsule

A. Avoid anterior chamber collapse in an effort to prevent vitreous prolapse by filling AC with an ophthalmic viscosurgical device (OVD) prior to stopping irrigation or removal of hand piece tip from the eye

B. Trap nucleus in anterior chamber to prevent its loss posteriorly by injecting a dispersive OVD behind lens material

C. Remove nucleus and its nuclear particles from the anterior segment

1. It is helpful to compartmentalize the eye with OVD and use "slow-motion" phaco settings (lower bottle height/aspiration/vacuum) to keep the OVD in position

D. Remove as much cortex as possible using manual irrigation and aspiration (I/A) if necessary

E. Remove IOL if necessary or position appropriately

F. Remove herniated vitreous

G. Perform posterior capsulorrhexis if possible or necessary

H. Insert appropriate intraocular lens (IOL) in stable position

IV. Describe various management techniques that may be used when faced with an open posterior capsule for each of the above stages

A. Phacoemulsification

1. Stop phacoemulsification
2. Do not allow AC to shallow
    a. Fill with OVD or air while maintaining irrigation to prevent vitreous prolapse
3. Manipulate the lens nucleus or nuclear fragments into the AC
    a. May be necessary to relax anterior capsulotomy by incising its edge if nucleus has not been fragmented
    b. May use posterior-assisted levitation maneuver
4. Trap nucleus in AC
    a. Compartmentalize with OVD
    b. Consider inserting a narrow Sheet's glide beneath nucleus
5. Remove nucleus
    a. Using phacoemulsification in the AC with protection of OVD, a second instrument, or lens glide
    b. Or, enlarge incision so that lens nucleus or nuclear particles may be removed manually with the aid of OVD and appropriate instrumentation
    c. Fill anterior chamber with OVD prior to removing the phaco tip

B. Irrigation and aspiration

1. Stop aspiration, continue with irrigation, lower bottle height
2. Fill AC with dispersive OVD before stopping irrigation and withdrawing I/A tip
3. If visualization and location allow, consider posterior capsulorrhexis
4. Either reduce flow of irrigation or plan to shift to manual stripping and removal of cortex
5. If vitreous already in AC, may need to perform anterior vitrectomy or pars plana vitrectomy
6. Bimanual vitrectomy techniques are ideal as to prevent hydration of vitreous
7. Staining of vitreous with non-preserved triamcinolone is useful for identifying residual vitreous in anterior chamber and ensuring its complete removal
8. Insertion of appropriate IOL in stable and appropriate position

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.54, 97, 206-210.
3. AAO, Focal Points: The Torn Posterior Capsule: Prevention, Recognition and Management, Module #4, 1999, p.5-7.
4. AAO, Focal Points: Phacoemulsification, Module #6, 1994, p.10.

Errant continuous curvilinear capsulorrhexis rescue and management

I. Describe alternatives to a continuous curvilinear capsulorrhexis (CCC)

A. Can opener capsulotomy

B. Diathermy or radio frequency needle

C. Vitrector capsulotomy

D. Retinal scissors capsulotomy

E. Femtosecond laser assisted capsulotomy

F. Plasma blade capsulotomy

II. Describe instruments and techniques used for performing a CCC

A. Maintain anterior chamber depth to create flat or scaphoid anterior capsule

1. Ophthalmic viscosurgical device (OVD)
2. Chamber maintainer and balanced salt solution
3. Use of small incision

B. Instrumentation

1. Needle
2. Forceps

C. Capsular stain if visualization difficult

D. Initiate tear through side port or main incision

1. Bent needle
2. Sharp pointed forceps or microforceps

E. Direct tear using instrument of choice

F. Keep pulling force directed so as to keep the capsulotomy centered and sized appropriately , re-grasping and repositioning as necessary

III. Describe the appropriate size for the CCC and why one might be considered too large or too small

A. Optimal size should be large enough to allow cataract removal and predictable intraocular lens (IOL) positioning.

B. Optimal size should be small enough to overlap anterior optic edge of IOL unless risk of capsular phimosis or excessive fibrosis warrants a larger diameter

1. Consider larger capsulorrhexis for dense nuclear sclerosis and pseudoexfoliation
2. Certain IOL designs may require a larger capsulotomy size (accommodative IOLs)

C. Optimal size should be small enough to stay within the anterior zonular attachment zone which varies with age

IV. List possible reasons a capsulorrhexis tear might deviate peripherally and how one would manage the situation

A. Tearing vector forces incorrectly applied

1. Not directly ahead but rather tangential or behind tear location
2. Regrasp flap near the leading edge of the tear

B. Peripheral zonular attachments encountered that stay intact and redirect tear

1. Lay torn flap directly on intact capsule
2. Fill anterior chamber (AC) with OVD
3. Regrasp flap at point of tear
4. Slowly pull flap in curving loop towards center
5. Resume normal tearing direction when central to zonular attachments
6. If point of tear beyond visualization, may need to restart tear going in the opposite direction

C. Increased posterior pressure

1. Keep AC maintained with OVD - make anterior capsule scaphoid
2. Physically hold lens posteriorly with second instrument
3. Shift to needle through side port rather than forceps through incision if viscoelastic escape is excessive
4. Avoid iatrogenic gaping of incision

D. Intumescent lens

1. Stain anterior lens capsule with trypan blue
2. Keep AC full of OVD
    a. Make anterior capsule scaphoid
3. Start tear by needle puncture rather than squeezing capsule with sharp forceps
4. Make initial diameter smaller than desired
5. Remove liquefied lens 'milk' with larger bore needle or other instrument to slowly decompress

V. Describe management options should the initial tear extend peripherally beyond recovery

A. Begin another tear in the opposite direction, ending the tear as close to the peripheral extension as possible

B. With AC refilled with OVD, lay anterior flap back down in anatomic pre-tear position, then pull flap in reverse tangential direction, i.e., pull force directed back along existing tear rather than ahead of tear (Little technique)

C. Convert to can opener capsulotomy

D. Consider salvaging rhexis edge with intraocular scissors to start new edge

E. Avoid stressing area of peripheral extension during emulsification as it is a weak point and may tear around to the posterior capsule

F. Avoid hydrodissection or use very low pressure with hydrodissection to avoid extension of anterior capsule tear to the posterior capsule

1. Consider hydrodelineation to separate nucleus and leave epinuclear shell as possible protection by reducing stress on capsule which might extend tear

G. When removing cortex, strip cortex towards capsular rent to avoid extending tear. Remove cortex adjacent to equatorial tear

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Little BC, Smith JH, Packer M. Little capsulorhexis tear-out rescue. J Cataract Refract Surg. 2006;32:1420-1422.

3. Marques FF, Marques DM, Osher RH, Osher JM. Fate of anterior capsule tears during cataract surgery. J Cataract Refract Surg. 2006 Oct;32(10):1638-42.

Intraoperative management of dropped nucleus

I. List preexisting conditions or intraoperative events which might result in a broken posterior capsule that could result in part or all of the nucleus being dropped into the vitreous

A. Posterior polar cataract

B. Calcified posterior subcapsular cataract

C. Posterior lenticonus

D. Iatrogenic posterior capsule tear during vitreoretinal surgery or intravitreal injection

E. Broken posterior capsule intraoperatively

F. History of trauma

II. Describe preoperative and intraoperative changes you might make if you thought the posterior capsule would likely be broken during surgery

A. Have correct instruments available:

1. Vitrector
2. Lens loop
3. Adequate ophthalmic viscosurgical device (OVD)
4. Consider local block

B. Place incision where it can be easily enlarged if needed

C. Large anterior capsulorrhexis through which whole nucleus could be delivered if needed

D. Knowledge of a nuclear handling technique to:

1. Avoid multiple lens fragments
2. Support and control entire nucleus without pressure or stresses on posterior capsule

E. Avoid hydrodissection if posterior capsule compromised before surgery

F. Attempt to leave posterior epinuclear shell in place by hydrodelineation

G. Prolapse nucleus anteriorly before emulsification using manipulation or OVDs

H. Avoid hypotony by filling the anterior chamber with OVD prior to removing instruments

I. Adjust fluidics to low-flow settings

III. Describe complications

A. Increased inflammation

B. Cystoid macular edema

C. Elevated intraocular pressure

D. Retinal detachment

IV. Describe surgical treatment options for dropped nuclear material

A. Stop phacoemulsification while maintaining intraocular pressure

B. Anterior approach elevation of nucleus and particles through pupil if not too posterior -use spoon, cyclodialysis spatula, cannula, OVD, etc.

1. Trap nucleus in anterior chamber using lens glide and/or OVD
2. Remove cataract material manually or with low bottle, conservative parameter emulsification

C. After the lens has dropped, perform an anterior vitrectomy (limbal or pars plana approach), remove cortex and if possible, place an IOL. Then, close and refer to vitreoretinal specialist who will perform a complete vitrectomy and remove lens fragments .

D. Do not "fish" for fragments or attempt to retrieve fragments deep in the vitreous cavity with the phaco needle

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.58.
3. Arbisser LB, Charles S, Howcroft M, et al. Management of vitreous loss and dropped nucleus during cataract surgery. Ophthalmol Clin North Am 2006;19:495-506.

Intraoperative management of iris prolapse

I. Describe iris prolapse and its consequences

A. Iris protruding through the incision

B. Intraoperative consequences

1. Pupillary constriction
2. Increased atonicity and floppiness of iris
3. Patient discomfort

C. Postoperative

1. Segmental loss of iris tissue and perhaps pupil function, aesthetic deformity, glare disability
2. Adhesions to anterior capsule, posterior capsule, etc. with pupil distortion
3. Possible iris incarceration, increasing risk for wound leak and endophthalmitis
4. Cystoid macular edema

II. List causes of iris prolapse

A. Incorrect incision

1. Too wide
2. Enters too near iris root
3. Incisional tunnel too short, iris pushes out

B. Excessive inflation of anterior segment with ophthalmic viscosurgical device (OVD)

C. Floppy iris particularly after pupil stretch or use of alpha 1a adrenergic antagonists, e.g., tamsulosin (Flomax®).

D. Increased posterior pressure (See Intraoperative shallowing of the anterior chamber)

E. Excessive fluid flow under iris with excessive flow out incision

F. Other causes of intraoperative shallowing of the anterior chamber (See Intraoperative shallowing of the anterior chamber)

G. Lack of adequate mydriasis prior to initiation of surgery

III. Describe management options for iris prolapse

A. Iris follows a pressure gradient; so anterior chamber pressure must first be reduced before iris can be repositioned

1. Gently press down on lens nucleus to remove trapped balanced salt solution from behind the lens
2. Reduce pressure by removing excessive OVD through paracenteses

B. Sweep iris from paracentesis site

C. Change settings to low-flow

D. Employ dispersive or highly retentive OVD to maintain concave iris near incisions

E. Perform peripheral iridectomy

F. Partially close incision if too large and possibly place glide in wound to prevent iris prolapse

G. Move to alternate incision site after closing first incision

H. Insert iris restraining devices, e.g., iris hooks or pupil ring, in problem area

I. Intracameral alpha agonists to help stabilize iris

J. Miotic administration at conclusion of surgery

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Management of intraoperative vitreous loss

I. List the potential adverse consequences associated with vitreous loss

A. Retinal tear/detachment

B. Cystoid macular edema

C. Endophthalmitis

D. Retained lens material, creating inflammation and glaucoma

E. Vitreous strands to incision

F. Bullous keratopathy and endothelial decompensation

G. Misshapen pupil

H. Secondary glaucoma

I. Intraocular lens subluxation or dislocation

II. Describe the intraoperative appearance of vitreous in the anterior segment

A. Clear, cohesive, raw egg white-like material

B. Displacement of other structures, iris, capsule, etc.

C. Other structures may move when vitreous is contacted or moved

D. Lens particles may become entrapped in it

E. Aspiration may seem less effective if vitreous entrapped in aspiration port

F. May be more easily visualized with air or intracameral triamcinolone suspension injection

III. Describe techniques to limit the amount of vitreous that may present in the anterior segment when it is not confined by an intact posterior capsule

A. Do not allow anterior chamber to collapse

1. Fill AC with an ophthalmic viscosurgical device (OVD) prior to discontinuing irrigation or removing instruments from the eye

B. Reduce irrigation flow and avoid area of vitreous as fluid can be diverted posteriorly and thus displace the vitreous anteriorly

IV. Describe techniques for anterior vitrectomy; including instrumentation, settings and maneuvers that may be used

A. Manual

1. Cellulose sponge and scissors at incision site externally for diagnosis
2. Constrict pupil to check for residual strands of vitreous

B. Automated vitrector - be knowledgeable of fluidics and mechanics of preferred machine

1. Limbal approach
    a. Bimanual approach with separate watertight irrigation and vitrector ports
    b. Suture main incision closed

c. Irrigating port is held high in the anterior chamber to maintain pressure gradient anterior to posterior

d. Vitreous cutter is placed in vitreous cavity

2. Pars plana approach

a. Ensure adequate anesthesia

i. If using topical anesthesia, a sub-Tenon's block may be given or a pledget soaked in tetracaine may be placed over the incision site for one minute

b. Bimanual approach with separate watertight irrigation (limbal) and vitrector (pars plana) ports. Ensure watertight closure of incisions and consider suture or ocular sealant

c. After making a small opening in the conjunctiva and cauterizing bleeding scleral vessels, an MVR blade (or sutureless trans-conjunctival trocar system depending on machine) is used to enter the vitreous cavity 3.5 mm from the limbus

d. Use highest cut rate available

e. Use setting in which vitreous cutter is engaged prior to vacuum (cut-I/A as opposed to I/A-cut) to avoid vitreous traction

3. Constrict pupil to reveal strands of vitreous which may have been overlooked

4. Don't cut where you can't see (under iris or posteriorly)

5. Consider preservative free triamcinolone injection to enhance vitreous visualization

6. Low threshold for suturing corneal incisions at the end of case

V. Describe any variations in postoperative management or follow up you might employ

A. Subconjunctival or intravitreal corticosteroid injection at procedure's conclusion

B. Indirect ophthalmoscopy to evaluate retina for tears or detachments

C. High dose topical corticosteroids and nonsteroidal anti-inflammatory drugs (NSAIDs) for long duration to reduce chance of cystoid macular edema

D. Consider use of acetazolamide if retained viscoelastic a concern

E. Retina consult

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Abbasoglu OE, Hosal B, Tekeli O, et al. Risk factors for vitreous loss in cataract surgery. Eur J Ophthalmol. 2000;10:227-32.

3. Arbisser LB, Charles S, Howcroft M, et al. Management of vitreous loss and dropped nucleus during cataract surgery. Ophthalmol Clin North Am 2006;19:495-506. Review.

4. Burk SE, Da Mata AP, Snyder ME, Schneider S, Osher RH, Cionni RJ. Visualizing vitreous using Kenalog suspension. J Cataract Refract Surg. 2003 Apr;29(4):645-51.

Postoperative shallow or flat anterior chamber

I. Describe the approach to establishing the diagnosis

A. Etiology

1. Wound leak (See Wound leak or filtering bleb (complication of cataract surgery))
2. Pupillary block
3. Aqueous misdirection (ciliary block glaucoma)
4. Suprachoroidal hemorrhage
5. Suprachoroidal effusion
6. Capsular block syndrome

B. Pertinent history

1. Postoperative eye trauma (including eye rubbing)
2. Ocular pain
3. Decreased vision
4. Redness
5. Tearing

C. Pertinent clinical features

1. Wound leak and choroidal effusion are associated with low intraocular pressure (IOP)
2. Shallow anterior chamber associated with normal or high IOP can be the result of pupillary block, aqueous misdirection, suprachoroidal hemorrhage or capsular block syndrome

D. Testing and evaluation

1. Intraocular pressure measurement
2. Slit lamp examination of the anterior chamber
    a. A uniformly flat chamber (centrally and peripherally) is most consistent with a posterior pushing mechanism i.e. aqueous misdirection, suprachoroidal hemorrhage, or wound leak
    b. An iris bombé configuration (more shallow peripherally than centrally) is typically present with pupillary block
    c. The presence of a distended posterior capsule with anterior displacement of the intraocular lens (IOL) is consistent with capsular distension syndrome
3. B scan ultrasound can demonstrate choroidal effusion or suprachoroidal hemorrhage
4. Anterior segment imaging (ultrasound biomicroscopy, anterior segment optical coherence tomography etc.)
5. Seidel test for wound leak
6. Patent peripheral iridotomy must be present to make the diagnosis of aqueous misdirection

II. Risk factors

A. Pupillary block

1. Uveitis with posterior synechiae
2. Anterior chamber lens without patent peripheral iridotomy
3. IOL placed upside down with angulated haptics leading to forward vaulting of optic

4. Iridovitreal synechiae

B. Aqueous misdirection

1. Prior history in contralateral eye
2. Nanophthalmos
3. Plateau iris
4. Cessation of cycloplegia or initiation of miotics

C. Suprachoroidal hemorrhage

1. Advanced age
2. Poorly controlled hypertension
3. Concomitant glaucoma procedure

D. Wound leak/choroidal effusion: See Wound leak or filtering bleb (complication of cataract surgery)

III. Patient management in terms of treatment and follow-up

A. Medical therapy options

1. Cycloplegia (atropine)
2. If high IOP: aqueous suppression and/or hyperosmotics
3. If low IOP with wound leak: See Wound leak or filtering bleb (complication of cataract surgery))

B. Surgical therapy options

1. Laser or surgical peripheral iridotomy for pupillary block (then permanent treatment of underlying etiology)
2. Disruption of anterior hyaloid face with neodymium yttrium-aluminum-garnet (Nd: YAG) laser surgery or vitrectomy for aqueous misdirection
3. Drainage of choroidal effusion or hemorrhage if non-resolving and associated with persistent flat anterior chamber
4. Nd: YAG anterior or posterior capsulotomy to relieve capsular block syndrome
5. If wound leak present, repair wound

IV. Complications of treatment, their prevention and management (See Wound leak or filtering bleb (complication of cataract surgery))

V. Disease-related complications

A. Peripheral anterior synechiae

B. Corneal decompensation

C. Visual loss

D. Optic nerve damage with sustained excessive IOP

E. Endophthalmitis with wound leak

F. Myopic shift with anterior displacement of IOL

G. Kissing choroidals with possible retinal detachment

VI. Patient instructions

A. Proper medication use

B. Eye shield

C. Avoid eye rubbing

D. Avoid Valsalva

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Stein JD1, Grossman DS, Mundy KM, Sugar A, Sloan FA. Severe adverse events after cataract surgery among medicare beneficiaries. Ophthalmology. 2011 Sep;118(9):1716-23.
3. Konstantopoulos A, Hossain P, Anderson DF. Recent advances in ophthalmic anterior segment imaging: a new era for ophthalmic diagnosis. Br J Ophthalmol. 2007 Apr;91(4):551-7.
4. Kaplowitz K, Yung E, Flynn R, Tsai JC. Current concepts in the treatment of vitreous block, also known as aqueous misdirection. Surv Ophthalmol. 2015 May-Jun;60(3):229-241.

Corneal edema after cataract surgery

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Acute endothelial dysfunction due to mechanical trauma, high ultrasonic energy exposure, prolonged intraocular irrigation, inflammation, or elevated intraocular pressure (IOP) in the postoperative period; or introduction of toxic substances (e.g., toxic anterior segment syndrome TASS))
2. Late endothelial dysfunction due to retained nuclear particles in the angle
3. Vitreocorneal adherence and persistent corneal edema may occur early or late after complicated extracapsular cataract extraction or phacoemulsification (or after uncomplicated intracapsular cataract extraction (ICCE))
4. Iris-clipped or closed-loop anterior chamber intraocular lenses (ACIOLs)
5. Malpositioned anterior chamber lenses
6. Descemet detachment

B. Define the relevant aspects of epidemiology of the disease

1. More common in patients with underlying corneal endothelial dysfunction such as Fuchs endothelial dystrophy
2. Shallow chamber eyes
3. Dense cataracts

C. List the pertinent elements of the history

1. Blurred, "foggy" vision
2. Diurnal fluctuation in vision with improvement at end of the day
3. If corneal edema significant with associated bullous keratopathy, patient symptoms include pain photophobia, foreign body sensation, epiphora

D. Describe pertinent clinical features

1. Corneal edema manifests as Descemet folds, corneal clouding, microcystic edema, and perhaps subepithelial bullae

II. Define the risk factors

A. Endothelial dystrophies including Fuchs; other endothelial disorders such as ICE, and those caused by ocular inflammatory disease such as H simplex keratitis/uveitis

B. Complicated cataract surgery with prolonged surgical time or vitreous loss

C. Closed-loop ACIOL

D. Prolonged phacoemulsification time (as with dense cataracts)

E. Phacoemulsification techniques with tip closer to endothelium

F. Shallow anterior chamber depth

G. Retained ophthalmic viscosurgical device (viscoelastic)

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Topical corticosteroids, topical hyperosmotic agents can be helpful and corneal edema generally resolves completely within 4-6 weeks following surgery
2. Aqueous suppressants if eye pressure is elevated

3. Bandage (therapeutic) contact lens if bullae are symptomatic

B. Describe surgical therapy options

1. Penetrating keratoplasty or endothelial keratoplasty (e.g. DSEK) if edema is not resolving and patient is symptomatic after appropriate waiting period after surgery (several months)
2. Early removal of retained lens fragments
3. YAG or incisional removal of vitreocorneal adhesions

IV. List the complications of treatment, their prevention and management

A. Complications of corticosteroid drops (e.g. IOP elevation)

B. Complications of bandage contact lens

1. Infectious keratitis
   a. Treated with aggressive antibiotic therapy
2. Tight lens syndrome
   a. Treated with lens replacement

C. Complications of penetrating keratoplasty

V. Describe appropriate patient instructions

A. Patients should be advised that resolution of corneal edema may take several weeks to months

B. Patients with dense brunescent cataracts and or endothelial dystrophy should be counseled regarding the increased risk for postoperative corneal edema

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Frigo AC, Fasolo A, Capuzzo C et al. CORTES Study Group. Corneal Transplantation Activity Over 7 Years: Changing Trends for Indications, Patient Demographics and Surgical Techniques From the Corneal Transplant Epidemiological Study (CORTES).. Transplant Proc. 2015 Mar;47(2):528-35.
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Cystoid macular edema

I. Establishing the diagnosis

A. Definition: Intra-retinal edema contained in cystoid spaces in the macula

B. Etiology

1. Increased perifoveal capillary permeability which results in capillary filtration that exceeds fluid resorption from the retina or choroid
2. Several hypotheses exist for the development of cystoid macular edema (CME) including:
    a. Inflammation
    b. Vitreomacular traction
    c. Exposure to ultraviolet light with generation of free radicals and/or stimulation of endogenous prostaglandin formation
3. CME may occur after cataract surgery without intraoperative complications

C. Epidemiology

1. Often asymptomatic, usually transient
2. Incidence based on visual loss is less than incidence based on fluorescein angiogram or OCT
    a. Clinical CME of 20/40 level or worse Approximately 2-10% of eyes following ICCE and 1-2% of eyes following ECCE with an intact posterior capsule
    b. Angiographic and OCT-based incidences are higher than those based on visual acuity
3. Most commonly associated with cataract surgery
4. Incidence is increased when there are additional risk factors

D. List the pertinent elements of the history

1. Visual impairment
    a. Central vision loss
    b. Metamorphopsia
2. Visual loss typically occurs 2-6 weeks after surgery, and may last for several weeks to several months, or longer
3. May run a fluctuating course, often associated with iritis or rebound iritis (e.g. after stopping anti-inflammatory drops)
4. Ask about past surgery, systemic disease, medications

E. Describe pertinent clinical features

1. Mild: loss of normal foveal architecture and light reflex
2. Often a yellow spot can be seen deep within the retina in the fovea
3. More advanced: prominent cysts or perifoveal thickening

F. Describe appropriate testing and evaluation for establishing the diagnosis

1. Clinical CME can be diagnosed by the appearance of the macula using the slit lamp biomicroscope and a fundus lens
2. Optical Coherence Tomography (OCT)
3. Fluorescein angiography can document CME (in a classic petaloid pattern) when the clinical exam and optical coherence tomography (OCT) is inconclusive

II. Risk factors

A. Intraocular inflammation

B. Posterior capsular rupture

C. Vitreomacular traction

D. Transient or prolonged hypotony

E. Use of epinephrine and dipivefrin medications for the treatment of aphakic glaucoma

F. Use of prostaglandin analogues following recent surgery

G. Malpositioned implants (one-piece IOL in the sulcus, iris tuck, intermittent corneal touch, pupillary capture, short anterior chamber lens), or iris-supported intraocular lenses (IOLs)

H. Patients with retinitis pigmentosa, uveitis, diabetes mellitus

I. Epiretinal membrane

J. Surgical trauma to iris or vitreous loss

K. Vitreous incarceration in wound

L. Post vitrectomy eyes

M. Post laser capsulotomy

III. Differential diagnosis

A. Age-related macular degeneration (AMD) associated with choroidal neovascular membrane

B. Diabetic macular edema

C. Macular hole

D. Retinal phototoxicity following cataract extraction

E. Epiretinal membrane

IV. Patient management in terms of treatment and follow-up

A. Medical therapy options

1. Topical corticosteroid and nonsteroidal anti-inflammatory drug (NSAID) drops
2. Oral NSAIDs
3. Oral carbonic anhydrase inhibitors
4. Cessation of offending medications

B. Surgical therapy options after failed medical management

1. Posterior sub-Tenon corticosteroid injection
    a. Intravitreal vascular endothelial growth factor (VEGF) inhibitor injection (evidence is low)
    b. Intravitreal corticosteroid injection
2. Nd:YAG laser or vitrectomy to lyse vitreous adhering to wound (to release vitreomacular traction)
3. IOL exchange if IOL is malpositioned
4. Vitrectomy (if vitreous traction or subluxed IOL)
5. Observation - often resolves without surgical treatment

V. Complications of treatment, their prevention and management

A. Complication of topical corticosteroid drops

1. Corticosteroid-induced glaucoma

a. IOP must be monitored while patients are on corticosteroid drops for IOP elevation

b. Corticosteroid drops should be tapered if possible

c. IOP controlled with a topical agent (not prostaglandin analogues)

2. Potentiation of herpes simplex virus keratitis

B. Complication of topical NSAID drops

1. Corneal epitheliopathy

a. The corneal status should be monitored while on therapy, especially if there is coexisting ocular surface disease

b. Increased lubrication, with non-preserved artificial tears, or punctal occlusion can improve the epitheliopathy

C. Complication of sub-Tenon corticosteroid injection

1. Inadvertent injection into the globe (prevented by careful technique)

2. Corticosteroid-induced glaucoma

a. If glaucoma occurs, IOP-lowering agents should be employed

b. If IOP is not responding to therapy, the depot corticosteroid may need to be surgically excised

D. Complication of oral NSAIDs

1. Gastric ulcers with prolonged use

2. Increased bleeding time

E. Complications of carbonic anhydrase inhibitors

1. Electrolyte abnormalities

2. Dehydration

3. Stevens Johnson Syndrome

4. Bone marrow depression

5. Kidney stones

F. Risks of intraocular corticosteroids and anti-VEGF agents include:

1. Prolonged elevation of IOP

2. Sterile and infectious endophthalmitis

3. Intraocular infection

4. Floaters/vitreous hemorrhage

G. Complications of laser surgery, injections or vitrectomy

VI. Disease-related complications

A. Vision loss—may be transient or permanent

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.58, 64.

3. Kessel L, Tendal B, Jørgensen K, et al.Post-cataract prevention of inflammation and macular edema by steroid and nonsteroidal anti-inflammatory eye drops: a systematic review. Ophthalmology. 2014 Oct;121(10):1915-24.

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Intravitreal bevacizumab for pseudophakic cystoid macular edema; a systematic review.. J Ophthalmic Vis Res. 2012 Jul;7(3):235.

Retinal detachment (complication of cataract surgery)

I. Approach to establishing the diagnosis

A. Etiology

1. Vitreoretinal traction following posterior vitreous detachment after cataract surgery
2. Complicated cataract surgery with broken posterior capsule and subsequent vitreoretinal traction

B. Relevant aspects of epidemiology of the disease

1. Occurs in an estimated 0.5%-2.0% of eyes following extracapsular cataract extraction
    a. Incidence is even smaller after phacoemulsification
2. Occurs in an estimated 2%-3% of eyes following intracapsular cataract extraction
3. Vitreous loss is associated with a greater than fourfold increase in the incidence of retinal detachment
4. Incidence increases in cases of axial myopia, particularly in young male patients without a posterior vitreous detachment
5. Prior history of trauma

C. Pertinent elements of the history

1. Flashes and floaters and/or a progressive shadow in the periphery (hours to years post-operatively)

II. Risk factors

A. Axial myopia greater than 25mm

B. Lattice degeneration of the retina

C. Previous retinal tear or detachment in the operated eye

D. History of retinal detachment in the fellow eye

E. Family history of retinal detachment, including hereditary conditions (e.g. Stickler syndrome)

F. Complicated cataract surgery with a broken posterior capsule and vitreous loss

G. Young age/male gender

H. Primary capsulotomy

III. Appropriate patient instructions

A. Postoperative cataract patients should be warned about symptoms of retinal detachment, especially if posterior capsular rupture and vitreous loss occurred, or if they exhibit other risk factors as stated above

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.63-64.
3. AAO, Focal Points: Evaluation of Impaired Visual Acuity Following Cataract Surgery, Module #6, 1996, p.2-3.
4. Clark A, Morlet N, Ng JQ, et al. Risk for retinal detachment after phacoemulsification: a whole-population study of cataract surgery outcomes. Arch Ophthalmol. 2012 Jul;130(7):882-8.

Endophthalmitis (complication of cataract surgery)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Patient's own external ocular flora
    a. Predominantly gram positive bacteria (over 90% of culture-positive cases) for acute endophthalmitis which occurs in the first week after surgery
    b. Majority are *Staphylococcus epidermidis*
    c. Gram negative infection less common and potentially more devastating (*Pseudomonas aeruginosa*)

B. Define the relevant aspects of epidemiology of the disease

1. Incidence is sporadic: 0.07% to 0.29%
2. May occur in "epidemics" with contaminated solutions, etc.
3. Incidence increases in cases with:
    a. Complex or complicated surgery
    b. Posterior capsule rupture
    c. Vitreous loss
    d. Wound leak or incompetence
    e. Immunologic incompetence
4. The source of the infectious organisms has been established as the patient's periocular flora in approximately 80% of cases
5. Povidone iodine surgical prep lowers risk
6. Careful draping of eyelids and lashes lowers risk
7. Intracameral antibiotics (Cefuroxime) lower risk in European studies

C. List the pertinent elements of the history

1. Visual loss, following improvement in vision after surgery
2. Pain in and above eye, brow aching
3. Redness
4. Peak incidence occurs most commonly in the first week after surgery
5. Lid swelling
6. Discharge

D. Describe pertinent clinical features

1. Conjunctival injection and chemosis
2. Corneal edema
3. Lid edema
4. Significant anterior chamber reaction (cells, flare, fibrin) +/- hypopyon
5. Vitritis (cells and loss of red reflex)
6. Pupillary space fibrin and/or posterior synechiae
7. Opacification of media

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Anterior chamber aspirate and vitreous biopsy specimens
2. Aqueous and vitreous smears, cultures and sensitivities
3. Eyelid margins and conjunctival cultures
4. Coordinate laboratory studies with microbiology laboratory
5. Escalating Intraocular inflammation

II. Define the risk factors

A. Ruptured posterior capsule increases incidence 4.5-14 times

B. Poor wound construction

C. Externalized vitreous wick

D. Increased age

E. Wound dehiscence

F. Breakdown of sterile technique

G. Anterior chamber surgical entrance wounds

H. Blepharitis, conjunctivitis, lacrimal system pathology

I. Complex or complicated cataract surgery

J. Immunocompromised host

K. Transscleral sutures

III. List the differential diagnosis

A. Toxic anterior segment syndrome

B. Retained lens material (lens-induced uveitis)

C. Post-operative inflammation

D. Severe uveitis with vitritis

E. Endogenous endophthalmitis

F. White blood cells vs red blood cells/pigment dispersion

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Seek posterior segment consultation when possible and where appropriate
2. According to the Endophthalmitis Vitrectomy Study (EVS), if vision is hand motion or better, vitreous tap/biopsy should be performed followed by intraocular injection of antibiotics
3. Antibiotics should be broad spectrum, such as vancomycin for gram-positive coverage (including MRSA) and ceftazidime or amikacin for gram-negative coverage
4. The EVS demonstrated there was no benefit in using systemic antibiotics
5. Systemic and intraocular corticosteroids may also be used to suppress the inflammatory response
6. Topical antibiotic drops used in all cases
    a. While there are no randomized studies to demonstrate the superiority of one prophylactic antibiotic over another, the newest generation fluoroquinolones have broader spectrum coverage and improved intraocular penetration than their predecessors.
    b. Use gram stain and sensitivity data to target the specific organism when available.
7. Cycloplegic drops and glaucoma medications are used as needed

B. Describe surgical therapy options

1. According to the EVS, if vision is light perception or worse, immediate vitrectomy should be performed (three port for biopsy/cultures and sensitivities) followed by intraocular injection of antibiotics (see above for choice of antibiotic)

C. Follow-up

1. Careful follow-up over first 48 hours after treatment
2. Initial signs that patient is responding to therapy include:
    a. Reduction in eye pain
    b. Improved anterior segment inflammation
3. If eye is more inflamed in both the anterior and posterior segments after initial treatment
    a. Vitrectomy should be performed (if not previously done)
    b. Cultures should be checked
    c. Appropriate antibiotics should be reinjected

V. Describe disease-related complications

A. Vision loss

B. Phthisis

C. Intracranial infection - cavernous sinus thrombosis

D. Loss of eye

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.62-63.
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17. Teoh SC, Lee JJ, Chee CK, et al. Recurrent Enterococcus faecalis endophthalmitis after phacoemulsification. J Cataract Refract Surg 2005;31:622-6.

18. Lalwani GA, Flynn HW Jr, Scott IU, Quinn CM, Berrocal AM, Davis JL, Murray TG, Smiddy WE, Miller D. Acute-onset endophthalmitis after clear corneal cataract surgery (1996-2005). Clinical features, causative organisms, and visual acuity outcomes. Ophthalmology. 2008 Mar;115(3):473-6. Epub 2007 Dec 11).

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21. Miller JJ, Scott IU, Flynn HW Jr, et al. Acute-onset endophthalmitis after cataract surgery (2000 -2004): incidence, clinical settings, and visual acuity outcomes after treatment. Am J Ophthalmol 2005;139:983-7.

22. Lundström M, Wejde G, Stenevi U, Thorburn W, Montan P.Endophthalmitis after cataract surgery: a nationwide prospective study evaluating incidence in relation to incision type and location. Ophthalmology. 2007 May;114(5):866-70. Epub 2007 Feb 26.

Wound leak or filtering bleb (complication of cataract surgery)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Wound leak with egress of aqueous through the wound

B. List the pertinent elements of the history

1. May be asymptomatic
2. Possible symptoms: irritation, excessive tearing, blurred vision, contact lens intolerance, pain

C. Describe pertinent clinical features

1. Depending on amount of wound leak, anterior chamber may be shallow or fully formed
2. Hypotony may exist and if present may lead to hypotony maculopathy
3. Wound will be Seidel positive if not covered by conjunctiva. May require mild globe pressure to demonstrate
4. If a scleral wound is buried under conjunctiva, an inadvertent filtering bleb may form
5. Chronic wound leaks are associated with fistula formation and possible epithelial downgrowth

II. Define the risk factors

A. Poorly constructed wound

B. Poor intraoperative wound closure

C. Poor patient wound healing

D. Vitreous or iris incarceration

E. Phaco burn

F. Eye rubbing or trauma

G. Biomechanical abnormality (e.g. corneal ectasia or collagen disorders)

H. Broken suture

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Wound leaks tend to be self-limited and usually respond to:
2. Pressure patching or use of bandage soft contact lens along with use of a shield to prevent eye rubbing or pressure on the eye
3. Suppression of aqueous production (with carbonic anhydrase inhibitors or beta-blockers)
4. Stimulation of wound healing by decreasing topical corticosteroids and nonsteroidal antiinflammatory drugs (NSAIDs)
5. Cycloplegia to reduce the risk of choroidals

B. Describe surgical therapy options

1. If there is a significant wound leak with shallow or flat anterior chamber, obvious wound separation, iris prolapse, or no improvement within 24-48 hours, the cataract wound should be revised taking care to remove any epithelial cells that may have created a fistulous tract

a. The wound should be sutured closed

b. Tissue adhesive or sealant in selected cases

2. Techniques to eliminate inadvertent bleb formation vary considerably and consist of procedures to enhance inflammation in the wound and seal the leak by cicatrization of the bleb

a. These include application of light cautery, penetrating diathermy, trichloroacetic acid (TCA) and cryotherapy

b. Scleral patch graft may be required in recalcitrant cases

IV. List the complications of treatment, their prevention and management

A. Complication of decreasing corticosteroids: increased anterior chamber inflammation or CME

B. Complication of wound revision: infection, induced astigmatism (prevented by avoiding overly tight suture closure), foreign body sensation

C. Complication of cautery, diathermy, cryotherapy, trichloroacetic acid (TCA) application to the inadvertent bleb: conjunctival buttonhole (prevented by cautious application)

V. Describe disease-related complications

A. Endophthalmitis

B. Hypotony maculopathy

C. Prolapse of uveal tissue through wound

D. Astigmatism

E. Contact lens intolerance

F. Corneal dellen

G. Choroidal effusion

H. Blurred vision

I. Epithelial downgrowth

J. IOL malposition with refractive changes

VI. Describe appropriate patient instructions

A. Proper medication use

B. Avoidance of eye rubbing

C. Minimal physical exertion

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, p.59.

Iridodialysis (complication of cataract surgery)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Occurs intraoperatively when the iris is torn at its root
2. Often occurs when an instrument or IOL haptic that is inadvertently engaging the iris is rapidly moved in or removed from the eye or during insertion of intraocular lens (IOL)

B. Describe pertinent clinical features

1. If small, may be optically and cosmetically acceptable
2. If large, may cause diplopia, induce glare, decrease in visual acuity, or may be bothersome to the patient cosmetically

II. Define the risk factors

A. Poor wound construction

B. Shallow anterior chamber

C. Multiple entry/exit of instruments through wound

D. Intraoperative iris prolapse through wound

E. Surgical manipulation of iris, i.e., synechiolysis

F. Intraoperative floppy iris syndrome

G. Poor view into the eye (corneal opacity or anterior chamber bleeding)

III. Describe patient management in terms of treatment and follow-up

A. Describe therapy options

1. Surgical reattachment of iris to sclera using non-absorbable suture (i.e. McCannel suture technique)
2. Intracameral steroids (triamcinolone) may be added if excessive iris manipulation occurs intraoperatively
3. Artificial iris implants
4. Cosmetic/light blocking contact lens

B. Describe specific post-operative considerations

1. Intensive steroid treatment is often necessary post-operatively when excessive iris manipulation is required intraoperatively
2. Use of an nonsteroidal anti-inflammatory drug (NSAID) drop postoperatively should be considered as iris manipulation can potentiate cystoid macular edema

IV. List the potential complications of treatment

A. Hyphema

B. Inflammation

C. Infection

D. Corneal edema

E. Suture erosion

F. Risks of contact lens

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Aqueous misdirection (malignant glaucoma)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Posterior misdirection of aqueous into the vitreous body displaces lens-iris diaphragm anteriorly, causing angle obstruction and increase in intraocular pressure (IOP)

B. Define the relevant aspects of epidemiology of the disease

1. Occurs following glaucoma surgery in 0.6% to 4% of eyes (with preexisting angle closure), occasionally after lens extraction
2. May occur spontaneously in eyes with open angles and/or without history of surgery (rarely)
3. Opposite eye is at increased risk of developing aqueous misdirection

C. List the pertinent elements of the history

1. Pain
2. Photophobia
3. Decreased vision
4. Red eye

D. Describe pertinent clinical features

1. Both the central and peripheral portions of the anterior chamber are very shallow
2. IOP is elevated
3. No choroidal effusion or swelling is present
4. A patent peripheral iridotomy may be present

II. Define the risk factors

A. Eye with acute or chronic-angle closure (usually eyes that were hyperopic pre-operatively)

B. Persistent shallowing of the anterior chamber in the perioperative period

III. List the differential diagnosis

A. Pupillary block

1. A peripheral iridotomy must be performed if not present to rule out pupillary block
2. The central chamber is generally deeper than the periphery.

B. Suprachoroidal hemorrhage

1. Usually more acutely painful
2. Frequently detected intraoperatively, whereas misdirection may not be noted until the following day (or later)
3. Often accompanied by a dark shadow increasing during surgery

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Treat aqueous misdirection
    a. Intensive cycloplegic therapy with atropine
    b. Stop/avoid cholinergics (may be aggravated by cholinergic therapy)
2. Treat elevated IOP
    a. Beta-adrenergic antagonists
    b. Alpha2- adrenergic agonists
    c. Carbonic anhydrase inhibitors (topical and oral)
    d. Hyperosmotic agents
3. Medical therapy successful in approximately 50% of patients
    a. May require 4 to 5 days of therapy duration

B. Describe surgical therapy options (laser surgery and incisional)

1. Nd: YAG laser surgery disruption of anterior vitreous face (aphakic or pseudophakic patients)
2. Argon laser photocoagulation of the ciliary processes
3. Pars plana vitrectomy (with or without glaucoma tube shunt)
4. Lens extraction with posterior capsulectomy and concurrent anterior hyaloid vitrectomy
5. In pseudophakic patients, iridectomy-hyaloido-zonulectomy combined with anterior vitrectomy

V. List the complications of treatment, their prevention and management

A. Intensive cycloplegic therapy

1. Dilated pupil
2. Blurred vision
3. Ocular discomfort
4. Systemic toxicity (e.g., tachycardia)

B. Complications of glaucoma medical therapy

C. Complications of glaucoma laser surgery and glaucoma incisional surgery and vitrectomy

1. Choroidal detachment
2. Retinal hemorrhage, tears, and/or detachment
3. Persistent elevated IOP
4. Recurrence of malignant glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Delayed postoperative inflammation after cataract surgery

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease - release of pro-inflammatory mediators due to the following:

1. Low-virulence bacterial pathogens (e.g. *Propionibacterium acnes*)
2. Retained lens material
3. Under-treatment of surgical trauma (e.g. premature withdrawal of anti-inflammatory medications)
4. Mechanical trauma from an intraocular lens (IOL)
    a. Rigid and closed-loop anterior chamber intraocular lenses
    b. One piece, square-edge optic IOL in ciliary sulcus
    c. Other IOL malpositioning (e.g. inverted IOL in sulcus)
5. Initial presentation of endogenous uveitis
6. Exacerbation of preexisting or chronic uveitis

B. List the pertinent elements of the history

1. In cases of endophthalmitis with low-virulence bacterial pathogens, patients may have few if any early symptoms, but develop light sensitivity, variable ocular redness, pain, and visual compromise weeks to months after surgery (delayed endophthalmitis)
2. In cases with significant retained lens material after complicated surgery, patients have varying levels of pain, redness, corneal edema (which may be progressive), and diminished vision

C. Describe pertinent clinical features

1. In delayed endophthalmitis, infection begins as low-grade inflammation which is transiently responsive to corticosteroids but returns or persists when the medication is tapered or stopped
    a. Later, granulomatous keratic precipitates may appear on the corneal endothelium and the IOL surface
    b. White plaques are commonly found in the capsular bag in cases of *Propionibacterium acnes*
2. In cases with retained lens material, an iritis or uveitis is seen which may be associated with increased intraocular pressure (IOP) and corneal decompensation. The corneal decompensation is often focal if early and diffuse latter in the clinical course
3. Gonioscopy may demonstrate small retained lens fragments, malpositioned implant haptics, and synechiae if corneal clarity allows visualization.
4. Iris atrophy/transillumination defects may also be present in cases of malpositioned intraocular lens

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. If any suspicion of endophthalmitis, aqueous and vitreous cultures should be taken immediately
    a. If capsular plaques are present, an attempt should be made to culture this material as well
2. Gonioscopy and ultrasound biomicroscopy can be helpful in select situations

II. Define the risk factors

A. Increased risk in patients with:

1. History of uveitis
2. Complicated cataract surgery e.g., vitreous loss

III. List the differential diagnosis

A. Infectious endophthalmitis

B. Retained lens fragments

C. Uveitis-Glaucoma-Hyphema syndrome secondary to older generation IOLs or improperly placed newer generation IOLs (e.g. one piece, square-edged IOL placed in sulcus)

D. Uveitis due to other etiologies

E. Malignancy

F. Ghost cells

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. If infection not suspected and no significant retained lens material
    a. Topical corticosteroids
    b. Nonsteroidal anti-inflammatory drugs
    c. Cycloplegics
    d. IOP control essential
2. Sub-Tenons or intravitreal corticosteroids

B. Describe surgical therapy options

1. If infection suspected: may use intravitreal/intracapsular injection of vancomycin for treatment of *Propionibacterium acnes*. (may require removal of IOL and lens capsule) (See Endophthalmitis (complication of cataract surgery))
2. If retained lens fragments are causing significant inflammation, they should be removed
3. Intraocular lenses causing chronic inflammation should be explanted, repositioned or fixated

V. Describe disease-related complications

A. Corneal decompensation

B. Cystoid macular edema

C. Inflammatory deposits on IOL

D. Accelerated posterior capsule opacification

E. Uveitic glaucoma

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.58.
3. Lane SS, Modi SS, Lehmann RP, et al. Nepafenac ophthalmic suspension 0.1% for the prevention and treatment of ocular inflammation associated with cataract surgery. J Cataract Refract Surg 2007;33:53-8.
4. Holland SP, Morck DW, Lee TL. Update on toxic anterior segment syndrome. Curr Opin Ophthalmol 2007;18:4-8.

Vitreous incarceration in wound

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Prolapse of vitreous through the pupil due to rupture of the anterior hyaloid face during surgery and adherence to the wound
2. Usually occurs in setting of posterior capsule rupture, but may also occur with an intact capsule in the setting of zonular dehiscence

B. Describe pertinent clinical features

1. Vitreous strand seen on slit lamp biomicroscopic exam extending to main wound or paracentesis site
2. Pupil often peaked

II. Define the risk factors

A. Incomplete removal of vitreous from the anterior segment during surgery

B. Posterior capsule tear

C. Zonular dialysis

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Corticosteroid drops for secondary ocular inflammation
2. Corticosteroid and non-steroidal anti-inflammatory drug (NSAID) drops for secondary cystoid macular edema (CME)

B. Describe surgical therapy options

1. Nd: YAG laser for lysis of fine vitreous strands
2. Micro scissors through paracentesis to cut vitreous stand
3. Vitrectomy may be required if there is considerable vitreous incarcerated in the wound with associated CME or uveitis that is unresponsive to medical therapy.
    a. A posterior approach may be advantageous in these cases

IV. List the complications of treatment, their prevention and management

A. Complications of topical corticosteroid and NSAIDs (See Cystoid macular edema)

B. Complications of Nd: YAG laser (See Neodymium yttrium-aluminum-garnet (Nd: YAG) laser posterior capsulotomy)

C. Complications of vitrectomy

V. Describe disease-related complications

A. Chronic inflammation

B. CME

C. Cosmetic pupil deformity

D. Glare symptoms

E. Endophthalmitis

F. Retinal tear or detachment

G. IOL decentration

VI. Describe appropriate patient instructions

A. Follow-up if vision loss or eye pain commences

B. Warning signs of retinal detachment should be discussed with the patient

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.62.

Induced astigmatism (complication of cataract surgery)

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Features of cataract incision (related to the length of the incision and the proximity to the center of the cornea)
2. Tight sutures
3. Corneal wound burn
4. Wound relaxation over time
5. Incorrect axis or arc length of relaxing incision, i.e., 90 degrees from intended due to incorrect surgical planning or transcription error
6. Gross misalignment of toric intraocular lens (IOL) (See Toric intraocular lenses (IOLs))
7. Lens tilt due to lens malposition or compromised capsular bag

B. Define the relevant aspects of history of the disease

1. The wider and more anterior the incision, the greater the induced cylinder

C. List the pertinent elements of the history

1. Blurred vision unless optical correction is in place

D. Describe pertinent clinical features

1. High (+) cylindrical axis points to the tightest suture
2. Corneal striae may be seen if sutures are very tight
3. With toric IOLs, axis alignment can be verified at the slit lamp
4. Signs of wound burn

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Keratometry
2. Topography
3. Refraction

II. Describe preventative measures

A. Adjustable sutures

1. Running
2. Slip knots

B. Evaluate cylinder intraoperatively

1. Keratoscopy
2. Keratometry
3. Aphakic refraction
4. Aberrometry

C. Avoid anterior incisions

D. Avoid wound burn

E. Multiple consistent preoperative K readings

F. Mark cardinal meridian with patient upright to identify cyclotorsion

G. 360 degree IOL edge cover to prevent lens tilt

H. Ensure both haptics in same anatomic space

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Eyeglasses
2. Contact lenses

B. Describe surgical therapy options

1. Suture lysis
2. Astigmatic keratotomy
3. Limbal relaxing incisions
4. Photorefractive keratectomy (PRK), LASIK
5. Repair of a wound dehiscence
6. Toric rotational repositioning
7. Repositioning of tilted intraocular lens

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Borasio E, Mehta JS, Maurino V. Surgically induced astigmatism after phacoemulsification in eyes with mild to moderate corneal astigmatism: temporal versus on-axis clear corneal incisions. J Cataract Refract Surg 2006;32:565-72.
3. George R, Rupauliha P, Sripriya AV, et al. Comparison of endothelial cell loss and surgically induced astigmatism following conventional extracapsular cataract surgery, manual small-incision surgery and phacoemulsification. Ophthalmic Epidemiol 2005;12:293-7.

Pupillary capture (complication of cataract surgery)

I. Describe the approach to establishing the diagnosis

A. Describe the definition of this disease

1. Partial or complete capture of the intraocular lens (IOL) optic in front of the pupil

B. List the pertinent elements of the history

1. Irregular pupil
2. Glare
3. Monocular diplopia
4. Photophobia
5. Blurred vision

C. Describe pertinent clinical features

1. Lens optic edge seen in front of pupil
2. Myopic shift
3. Induced astigmatism from lens tilt
4. Chronic uveitis

II. Define the risk factors

A. Upside down IOL with angulated haptics with resultant forward vaulting of the optic

B. Positive vitreous pressure behind the optic

C. IOL in ciliary sulcus without optic capture

D. Iridocapsular adhesion

E. Capsulorrhexis larger than IOL optic, or can-opener capsulotomy

F. Wound leak resulting in forward migration of lens optic

G. Piggybacking of two IOLs in posterior chamber

H. Small diameter IOL

I. Scleral fixated IOL placed too anteriorly

J. Subsequent vitreal surgery mechanically displacing the IOL

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. If patient is asymptomatic, no treatment required

B. Describe surgical therapy options

1. Intraoperative lens repositioning
2. Breaking of synechiae if present
3. Intraocular lens exchange
4. Nd: YAG laser lysis of adhesions and retroplacement of optic

5. Pupilloplasty

6. YAG peripheral iridotomy if pupillary block

IV. List the complications of treatment, their prevention and management

A. Risk of infection with surgical lens repositioning or exchange

B. If capture long standing or synechiae are extensive, repositioning of IOL could result in rupture of the posterior capsule and dislocation of the IOL

V. Describe disease-related complications

A. Pupillary block glaucoma

B. Myopic shift

C. Induced astigmatism

D. Chronic iritis

VI. Describe appropriate patient instructions

A. Appropriate use of medications

B. Instructions to return with decreased vision, redness or pain

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Undesired optical images associated with intraocular lens implants

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Glare, streaks, halos, rings, or arcs from a source of light (positive dysphotopsia) may occur from properly positioned, malpositioned, or multifocal intraocular lens (IOL) implants
2. Temporal dark crescent (negative dysphotopsia)
    a. There is significant controversy regarding origin and treatment of negative dysphotopsia

B. List the pertinent elements of the history

1. Visual disturbances following cataract surgery, typically noticed in the early post-operative period

C. Describe pertinent clinical features

1. IOL may be poorly centered
2. IOL optic may not be covered by the capsulorrhexis edge for 360 degrees
3. This complication may occur in the presence of a well-positioned posterior chamber IOL in the capsular bag after uncomplicated cataract surgery
4. Posterior capsular plaques (seen with posterior subcapsular cataracts, post-vitrectomy cataracts and traumatic cataracts) may predispose to glare and halos
5. Posterior capsular opacities or wrinkles

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Complete ophthalmic examination, including dilated fundus evaluation

II. Define the risk factors

A. Multifocal optic worse than monofocal optic

B. Small diameter optic

C. Large pupil

D. Decentered IOL

E. Iris transillumination defects

III. List the differential diagnosis

A. If a patient complains of flashes of light postoperatively, must differentiate between retinal photopsia (secondary to posterior vitreous detachment or retinal detachment) and optical reflections

IV. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Reassurance
2. Miotics for pupillary construction or brimonidine for mild miotic effect for use under low-light conditions
3. With time, anterior capsular opacification may reduce symptoms

B. Describe surgical therapy options

1. IOL exchange if patient is debilitated by symptoms
2. IOL recentration if necessary
3. Iris repair if responsible for symptoms
4. Repositioning of optic anterior to anterior capsule has been described for negative dysphotopsia (reverse optic capture or sulcus placement of the lens)
5. Placement of zero power piggyback sulcus IOL has been described for negative dysphotopsia

V. Describe appropriate patient instructions

A. In the setting of a normal eye exam, patients should be reassured that there is no organic pathology that is causing the dysphotopsia and that it is often seen after uncomplicated cataract surgery and can occur with any available intraocular lens

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Davison JA. Positive and negative dysphotopsia in patients with acrylic intraocular lenses. J Cataract Refract Surg. 2000 Sep;26(9):1346-55.
3. Masket S, Fram N.Pseudophakic negative dysphotopsia: surgical management and new theory of etiology. J Cataract Refract Surg.2011;37(7):1199-1207.

Posterior capsule opacification

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Migration, proliferation, and metaplasia of viable lens epithelial cells across the posterior capsule with secondary capsular wrinkling and opacification

B. Define the relevant aspects of epidemiology of the disease

1. Most common complication of modern cataract surgery (extracapsular cataract extraction and phacoemulsification)
2. Incidence varies with patient age, lens material and edge design

C. List the pertinent elements of the history

1. Decreased vision
2. Glare

D. Describe pertinent clinical features

1. Posterior capsule wrinkles and opacification
2. Opacification either due to fibrosis, Elschnig pearls or a combination

II. Define the risk factors

A. Incomplete cortical clean-up

B. History of intraocular inflammation

C. Younger age

D. Round edge intraocular lens (IOL)

E. Longer postoperative interval

F. IOL in sulcus

G. Continuous curvilinear capsulorrhexis diameter larger than optic

H. Posterior subcapsular cataracts

I. Silicone oil

J. Previous vitrectomy

III. Describe patient management in terms of treatment and follow-up

A. Describe surgical therapy options

1. Nd:YAG laser posterior capsulotomy
2. Observation
3. Surgical posterior capsulotomy (e.g., child can't sit for laser or scar impervious to laser)
4. Surgical removal of pearling, leaving intact capsule

IV. List the complications of treatment, their prevention and management (See Neodymium yttrium-aluminum-garnet (Nd:YAG) laser posterior capsulotomy)

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.77, 80, 90, 95, 104-110.

3. Kugelberg M, Wejde G, Jayaram H, et al. Posterior capsule opacification after implantation of a hydrophilic or a hydrophobic acrylic intraocular lens: one-year follow-up. J Cataract Refract Surg 2006;32:1627-31.

4. Dewey S. Posterior capsule opacification. Curr Opin Ophthalmol 2006;17:45-53.

5. Menapace R, Wirtitsch M, Findl O, et al. Effect of anterior capsule polishing on posterior capsule opacification and neodymium:YAG capsulotomy rates: three-year randomized trial. J Cataract Refract Surg 2005;31:2067-75.

6. Hayashi K, Hayashi H. Posterior capsule opacification in the presence of an intraocular lens with a sharp versus rounded optic edge. Ophthalmology 2005;112:1550-6.

7. Sacu S, Menapace R, Findl O, et al. Long-term efficacy of adding a sharp posterior optic edge to a three-piece silicone intraocular lens on capsule opacification: five-year results of a randomized study. Am J Ophthalmol 2005;139:696-703.

Anterior capsule fibrosis and phimosis

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Opacification and/or contraction of the anterior capsule due to migration, proliferation, and metaplasia of lens epithelial cells, with formation of myofibroblasts
2. Weak zonules (history of: retinitis pigmentosa, trauma, pseudoexfoliation, uveitis)
3. Often a small initial rhexis

B. List the pertinent elements of the history

1. Decreased vision when capsular phimosis results in lens decentration, tilt, or extends into visual axis
2. Glare
3. Sensation of peripheral cloud or haze

C. Describe pertinent clinical features

1. Anterior capsular opacification (fibrosis) and variable amount of capsular contraction (phimosis)
2. Zonular traction and potential weakening
3. Intraocular lens (IOL) subluxation or tilt

II. Define the risk factors

A. Small capsulorrhexis

B. Abnormal or asymmetric zonular support (e.g., RP, uveitis, pseudoexfoliation of the lens capsule, post-trauma, Marfan syndrome, or surgical trauma)

C. Silicone plate haptic intraocular lenses (IOLs) (anterior capsular fibrosis can be seen with all IOL designs, but is more common with plate haptic IOLs)

III. Describe patient management in terms of treatment and follow-up

A. Describe surgical therapy options

1. In certain cases, (RP, uveitis) a capsular tension ring placed at the time of cataract surgery may help mitigate risk
2. Relaxing incisions in the anterior capsule may be created radially with Nd: YAG laser
3. Care should be taken not to defocus the beam too far posteriorly (to avoid lens pitting)
4. Anterior capsule fibrosis is resilient and requires more laser energy than the posterior capsule

IV. List the complications of treatment, their prevention and management

A. Transient elevation of intraocular pressure (IOP)

1. Pre and post treatment with apraclonidine or brimonidine

B. Retinal tear/detachment

1. Pretreatment examination of peripheral retina
2. Referral/treatment of preexisting retinal breaks

C. Uveitis/cystoid macular edema

1. Can be induced by trauma to the iris by misdirected laser pulses
2. Can be induced by liberation of lens material and release/stimulation of endogenous prostaglandins
3. Rare cases may involve treatment of Soemmerring ring lens remnants with subsequent inflammation and elevation of IOP
4. May be managed by frequent observation and treatment with topical corticosteroids and ocular antihypertensive agents

D. Damage to IOLs

1. Laser damage may induce pitting of lens optic with potential for reduced visual function.
2. May be prevented by anterior defocus of laser beam and with the aid of a contact lens to increase the cone angle and the irradiance of the laser light
3. Avoid the central portion of the IOL if possible

E. Dislocation of the IOL

1. Posterior dislocation of plate haptic silicone IOLs
    a. Associated with first generation silicone IOLs that induce significant anterior capsule fibrosis and posterior bowing of IOL
    b. May be prevented with circular shaped posterior capsulotomy and anterior capsule laser relaxing incisions as needed
2. Dislocation of looped lenses occurs very rarely and only in cases with markedly abnormal capsule/implant attachments
3. Can induce asymmetric orientation of haptics (Z syndrome) or vaulting of accommodating lenses (Crystalens)
4. Dislocated IOLs may require additional surgery to reposition or remove and replace the original IOL

V. Describe disease-related complications

A. Possible IOL decentration

B. Decrease in visual acuity or quality if capsular phimosis is significant

C. Poor visibility of peripheral retina

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Neodymium yttrium-aluminum-garnet (Nd:YAG) laser posterior capsulotomy

I. List the indications/ contraindications

A. Indications

1. Visually symptomatic posterior capsule opacification (PCO), striae, etc.
2. Enhanced view of posterior segment for potential posterior segment therapeutic intervention
3. Posterior capsular distention syndrome
4. Intraocular lens (IOL) tilt, e.g. Z syndrome with an accommodative IOL

B. Contraindications

1. Patient does not desire/require improved vision
2. Visual symptoms not caused by PCO, i.e., dysphotopsia
3. Lens implant exchange a likely possibility
4. Positional stability of IOL uncertain
5. Untreated acute retinal tear

II. Describe the pre-procedure evaluation

A. Comprehensive eye examination to determine that PCO is the cause of reduced vision

1. In patients with diabetes mellitus, careful retinal evaluation necessary to assess degree of retinopathy since opening posterior capsule can increase incidence of neovascularization of the iris (NVI), neovascularization of the angle (NVA), neovascularization glaucoma (NVG), and clinically significant macular edema
    a. Retinopathy should be treated first if possible or as soon as is practical after capsulotomy

III. List the alternatives to this procedure

A. Surgical capsulotomy with needle/knife

B. Surgical polishing of capsule

IV. Describe the instrumentation, anesthesia, and technique

A. Instrumentation

1. Q-switched or mode-locked Nd: YAG laser/slit lamp apparatus with He: Ne aiming beam(s)

B. Anesthesia

1. Topical anesthesia

C. Technique

1. Pharmacologic pupil dilation (optional)
2. Pretreatment with apraclonidine 0.5% or 1% or brimonidine (optional)
3. Patient comfortably seated and positioned at slit-lamp biomicroscope/laser, secure forehead
4. Use of contact lens recommended
5. Posterior defocus of laser beam (if necessary)

6. Application of laser to capsule

7. Application of apraclonidine 0.5% or 1.0% or brimonidine post-laser surgery for intraocular pressure (IOP) elevation prophylaxis (other topical glaucoma medications can also be used) if at risk for elevated IOP

8. Measure IOP in high risk individuals

V. List the complications of the procedure and prevention and management

A. Transient elevation of intraocular pressure (IOP)

1. Pretreatment with apraclonidine or brimonidine

2. Posttreatment with apraclonidine or brimonidine

B. Vitreous prolapse into anterior chamber

1. More common in aphakic eyes

2. Don't allow capsular opening to extend beyond the edge of the optic.

C. Retinal tear/detachment

1. Pretreatment examination of peripheral retina

2. Referral/treatment of preexisting retinal breaks

D. Uveitis/cystoid macular edema - can be induced by liberation of lens material and release/stimulation of endogenous prostaglandins

1. Rare cases may involve treatment of Soemmerring ring lens remnants with subsequent inflammation and elevation of IOP

2. May be managed by frequent observation and treatment with topical corticosteroids and/or NSAIDs and ocular antihypertensive agents

E. Damage to IOLs

1. Laser damage may induce pitting of lens optic with potential for reduced visual function.

2. May be prevented by posterior defocus of laser beam and with the aid of a contact lens to increase the cone angle and the irradiance of the laser light

F. Dislocation of the IOL

1. Posterior dislocation of plate haptic silicone IOLs

   a. Associated with first generation silicone IOLs that induce significant anterior capsule fibrosis and posterior bowing of IOL

   b. Incidence can be reduced with small circular shaped posterior capsulotomy and anterior capsule laser relaxing incisions as needed

2. Dislocation of looped lenses occurs very rarely and only in cases with markedly abnormal capsule/implant security

3. Dislocated IOLs may require additional surgery to reposition or remove and replace the original IOL

G. NVI in diabetic patients

H. Corneal surface changes associated with contact lens, e.g. punctate epithelial erosions (PEE), corneal abrasion

VI. Describe the follow-up care

A. High risk individuals for IOP elevation (glaucoma cases) should have IOP measured

B. Patients should be made aware of symptoms related to acute posterior vitreous detachment and encouraged to report such symptoms and be examined without delay

C. In those cases with liberated lens material, follow-up is necessary to evaluate inflammation and/or elevation of IOP

D. Diabetic patients need careful follow-up of retina and iris

VII. Describe appropriate patient instructions

A. Patients can return to full activities immediately following laser treatment with normal post dilation precautions

B. Patients must be encouraged to report any reduction in vision, alteration in field of vision, and onset of light flashes followed by "floaters"

C. Patients should be made aware that small "floaters" are commonly noted transiently following laser capsulotomy

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Newland TJ, McDermott ML, Eliott D, et al. Experimental neodymium:YAG laser damage to acrylic, poly (methyl methacrylate), and silicone intraocular lens material. J Cataract Refract Surg 1999;25:72-76.
3. Javitt JC, Tielsch JM, Canner JK, et al. National outcomes of cataract extraction. Increased risk of retinal complications with Nd:YAG laser capsulotomy. The Cataract Patient Outcomes Team. Ophthalmology 1992;99:1487-1498.
4. Menapace R, Wirtitsch M, Findl O, et al. Effect of anterior capsule polishing on posterior capsule opacification and neodymium:YAG capsulotomy rates: three-year randomized trial. J Cataract Refract Surg 2005;31:2067-75.

Intraocular lens decentration and dislocation

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disease

1. Asymmetric haptic placement with one haptic in the capsular bag and the other in the sulcus
2. Tear in anterior or posterior capsule
3. Broken/damaged haptic
4. Broken intraocular lens (IOL) fixation suture
5. Eccentric, excessively large, or torn capsulorrhexis
6. Insufficient zonular support
7. Irregular fibrosis of the capsular bag
8. Residual lens material
9. Implantation of IOL with insufficient haptic length in ciliary sulcus

B. Define the relevant aspects of epidemiology of the disease

1. Late IOL dislocation may be seen in patients with
    a. Progressive zonulopathy (e.g. Pseudoexfoliation syndrome, uveitis, retinitis pigmentosa)
    b. Broken scleral or iris fixation suture
    c. Neodymium: yttrium-aluminum-garnet (Nd: YAG) capsulotomy with plate haptic IOL
    d. Axial myopia with large anterior segment
    e. Broken, damaged or "stuck" haptic
    f. Trauma

C. List the pertinent elements of the history

1. Depending on degree of decentration, patient symptoms range from being asymptomatic to severe glare, diplopia (monocular) and reduced vision
2. If the IOL dislocates posteriorly, patients will note sudden blurred vision

D. Describe pertinent clinical features

1. In symptomatic patients, the edge of the IOL is typically seen within the undilated pupil
2. In cases of late dislocation, the entire IOL-capsule complex may be noted to be floating in the vitreous
3. Examine the patient in supine position to see if lens moves posterior
4. Small amounts of decentration of a multifocal IOL may be symptomatic

II. Define the risk factors

A. Pseudoexfoliation syndrome or any condition with progressive loss or weakening of zonules

B. History of trauma, including prior posterior segment surgery, with or without loose zonules

C. Complicated intraoperative course with loss of zonules or capsular rupture

D. Sulcus placement of IOL

E. Plate-haptic lens requiring posterior capsulotomy

F. Poorly dilating pupil with uncertain placement of IOL haptics during surgery

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Use of pilocarpine or brimonidine to keep pupil constricted so edge of IOL no longer in pupil zone

B. Describe surgical therapy options

1. Surgical options much easier prior to YAG capsulotomy
2. If irregular capsule fibrosis and intact zonules, or if one haptic is in the bag and the other is in the sulcus, reposition IOL by dialing haptics so both are in the bag or both are in the ciliary sulcus space (if the IOL is compatible with sulcus) with optic capture if possible
    a. A one-piece acrylic lens should not be placed in the sulcus or sutured
        i. The square thick edges and the short length cause iris chafing, iritis and may cause elevated intraocular pressure (IOP)
        ii. If bag placement is not possible, the lens should be removed and may be replaced with a 3-piece lens long enough for the sulcus or an anterior chamber lens
3. If zonules are compromised, trans-iris IOL fixation sutures (McCannel sutures) or scleral sutures may be used to secure and center the IOL
4. The IOL may be removed altogether and replaced with either an anterior chamber IOL, a scleral supported posterior chamber IOL or an iris-fixated IOL

IV. List the complications of treatment, their prevention and management.

A. The IOL may fall into the vitreous cavity during attempt at lens repositioning. This would require referral to a vitreoretinal specialist.

B. Vitreous traction/detachment

C. Late suture failure

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 100-101.
3. Hayashi K, Hirata A, Hayashi H. Possible predisposing factors for in-the-bag and out-of-the-bag intraocular lens dislocation and outcomes of intraocular lens exchange surgery. Ophthalmology. 2007 May;114(5):969-75. Epub 2007 Feb 23.

Incorrect intraocular lens power

I. Describe the approach to establishing the diagnosis

A. Describe the etiology of this disorder

1. Preoperative conditions (See Estimation of intraocular lens power)
    a. Preoperative error of biometry (axial length measurement or keratometry readings)
    b. Use of inaccurate data into intraocular lens (IOL) power calculation formula (improper lens calculation)
    c. Prior refractive surgery
    d. Failure of formula to correctly predict the effective lens position
    e. Manufacturing defects or mislabeled IOL - rare
2. Intraoperative conditions
    a. Inverting the IOL upon insertion so that the angulation of the optic is anterior rather that posterior
    b. Placing an IOL intended for the capsular bag into the ciliary sulcus
    c. Placement of wrong IOL into eye
3. Postoperative conditions
    a. It is critical to rule out transient causes of IOL power surprises which include
        i. Capsule block syndrome (IOL power likely correct once capsule distention is resolved) causes myopic shift
        ii. Shallowed anterior chamber (hypotony, choroidal effusion, etc.) causes hyperopic refractive shift
        iii. Dry or edematous cornea
        iv. Macular edema causes hyperopic shift
        v. Fluctuation in corneal curvature in patients that have undergone radial keratotomy
        vi. Z syndrome and vaulting of accommodating IOLs

B. List the pertinent elements of the history

1. Poor communication with patient regarding refractive goal
2. Prior refractive surgery

C. Describe pertinent clinical features

1. IOL may be inverted
2. IOL may be in the ciliary sulcus
3. Capsule distension in cases of capsule block syndrome

D. Describe appropriate testing and evaluation for establishing the diagnosis

1. Verify that the power of the inserted IOL was the intended power
2. The axial length and the keratometry can be rechecked postoperatively
3. Dilated anterior segment exam for capsular block and proper orientation/location of the IOL
4. Serial refractions to check for stability

II. Define the risk factors

A. Choosing the correct power IOL is more difficult in

1. Patients undergoing simultaneous penetrating keratoplasty or retinal detachment repair
2. Patients with silicone oil in the vitreous cavity
3. Patients who have had prior refractive surgery
4. Patients with staphyloma, extremely short or long eye, uncooperative for exam
5. Dense cataracts when you must rely on B-scan
6. Patients that have undergone scleral buckling procedures

III. Describe patient management in terms of treatment and follow-up

A. Describe medical therapy options

1. Eyeglasses
2. Contact lenses

B. Describe surgical therapy options

1. IOL exchange
2. Piggyback IOL
3. Keratorefractive surgery
4. Nd:YAG laser anterior or posterior capsulotomy for capsule block

C. Incorrect IOL power is a high risk event and requires effective communication with patient

IV. List the complications of treatment, their prevention and management

A. Complication of IOL exchange

1. Posterior capsular rupture
2. Zonular compromise
3. Bullous keratopathy

B. Complications of refractive surgery

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Patients with anticoagulation therapy or bleeding diathesis and cataract surgery

I. List the surgical complications for which the patient is at increased risk

A. If anticoagulation therapy is discontinued

1. Thromboembolism (cerebrovascular accident, myocardial infarction, pulmonary embolism, peripheral vascular occlusion)
2. Surgeon should consult with internist, hematologist, and/or cardiologist prior to discontinuing systemic anticoagulation

B. If bleeding diathesis is reversed by platelet transfusion, blood transfusion, factor deficiency infusion

1. Risks specific to medical therapy of bleeding diathesis
2. Thromboembolism

C. If anticoagulation is continued

1. Exacerbation of bleeding from needle puncture, incision or operative hemorrhage, though rarely has implications beyond cosmesis of ecchymosis or subconjunctival hemorrhage.
2. Increased risk of retrobulbar hemorrhage with retrobulbar injections, thus consider advantages of topical, peribulbar, or Sub-Tenon anesthesia in which orbital hemorrhage (if it were to occur) would be outside the muscle cone and, accordingly, rarely, if ever would impinge on the optic nerve
3. Does not increase the risk of spontaneous suprachoroidal hemorrhage if International Normalized Ratio (INR) is in therapeutic range

D. If bleeding diathesis is untreated

1. Exacerbation of bleeding from needle puncture, incision or operative hemorrhage
2. Increased risk of retrobulbar hemorrhage with retrobulbar injections
    a. Consider advantages of topical, peribulbar, or Sub-Tenon anesthesia in which orbital hemorrhage (if it were to occur) would be outside the muscle cone and rarely would impinge on the optic nerve

E. If non-prescription medications (aspirin, ibuprofen) or herbal supplements (e.g., ginkgo biloba, ginger, garlic, ginseng, high doses of vitamin E) are being used they can augment and/or cause bleeding problems

II. List steps that can be taken to reduce the operative risks

A. Use clear cornea approach to minimize bleeding

B. Use cautery as needed if a scleral incision approach is taken

C. Use topical phenylephrine or epinephrine to control surface bleeding

D. Consider topical anesthesia (or general anesthesia) over injection anesthesia to minimize the odds of a posterior orbital hemorrhage

E. Small incision cataract surgery reduces the risk for suprachoroidal hemorrhage

F. Manage systemic hypertension.

G. Use of viscoelastics to stabilize chamber and prevent chamber decompression

III. Is the follow up care different than for routine surgery?

A. If surgery is uneventful and anticoagulation was discontinued, restart it immediately

B. If anticoagulation was not discontinued, no change if IOP is normal range or above. Valsalva precautions if hypotensive

IV. Are the patient instructions different (post-op care, vision rehabilitation)?

A. Caution patient about the possibility of postoperative periorbital ecchymosis if orbital injection anesthesia is administered

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p.51-52.
3. Carter K, Miller KM. Phacoemulsification and lens implantation in patients treated with aspirin or warfarin. J Cataract Refract Surg. 1998; 24:1361-4.

Patients with diabetes mellitus and cataract surgery

I. Describe how the high-risk characteristic or comorbidity affects the surgical condition

A. Diabetes mellitus hastens cataract development

B. Glycogen storage within iris pigment epithelial cells may impair pupil dilation

C. Diabetic Macular edema affecting preoperative axial length measurements

D. Advanced diabetic eye disease may be associated with iris neovascularization and associated complications

1. Poorly dilating pupil
2. Angle neovascularization, iris sphincter neovascularization
3. Posterior synechiae development
4. Spontaneous hyphema and/or bleeding during cataract surgery

II. List the surgical complications for which the patient is at increased risk

A. Worsening of iris neovascularization including neovascular glaucoma

B. Worsening of diabetic retinopathy

C. Clinically significant macular edema

D. Vitreous hemorrhage

E. Anterior chamber hemorrhage

F. Silicone lens calcifications if asteroid hyalosis also present

G. Poor wound healing

H. Sloughing of epithelium

III. List steps that can be taken to reduce the operative risks

A. Obtain good control of blood glucose before operating

B. Careful preoperative slit-lamp biomicroscopic examination including gonioscopy (when indicated) to detect iris neovascularization

C. Treat preexisting clinically significant diabetic macular edema and proliferative diabetic retinopathy or high risk non-proliferative diabetic retinopathy with laser or injections. Consider pre-op evaluation with retinal subspecialist

D. Consider advantages versus risks of combining procedure with vitreoretinal surgeon for simultaneous vitrectomy and endolaser if significant proliferative disease or vitreous hemorrhage is present and the view precludes their preoperative treatment

E. In general, there is inadequate data to support the use of one lens material over another in diabetic eyes at low risk for subsequent vitreous surgery; however, silicone intraocular lenses should be avoided in diabetic eyes at high risk for subsequent vitreous surgery in which silicone oil might be injected

F. Topical nonsteroidal anti-inflammatory drug agents (NSAIDs) preoperatively and postoperatively as needed

G. In cases where the macular status is difficult to clearly define on exam, pre-operative optical coherence tomography, fluorescein angiography, or both should be considered

H. In cases of refractory or recurrent macular edema may consider use of anti-vascular endothelial growth factor (Anti-VEGF) injection

IV. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Cataract surgery may accelerate the progression of diabetic retinopathy and diabetic macular edema

B. Cataract surgery may trigger the development of rubeosis, particularly in the setting of significant retinal nonperfusion and capsule rupture

C. Diabetes mellitus is associated with accelerated posterior capsule opacification and anterior capsule contraction

D. Possible limitation of final visual acuity due to macular edema, hemorrhage, lipid deposition, ischemia, or membrane formation

V. Is the follow up care different than for routine surgery?

A. The follow-up interval is dictated by the severity of the diabetic retinopathy, if any

B. Postoperative inflammation should be treated aggressively to reduce the risk of diabetic macular edema

C. Consider vitreoretinal consult in higher risk cases

D. Longer term post-operative use of NSAIDs in at risk patients is advocated by some

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Murtha T, Cavallerano J. The management of diabetic eye disease in the setting of cataract surgery. Curr Opin Ophthalmol 2007;18:13-8. Review.
3. Takamura Y, Kubo E, Akagi Y.Analysis of the effect of intravitreal bevacizumab injection on diabetic macular edema after cataract surgery. Ophthalmology. 2009 Jun;116(6):1151-7. Epub 2009 Apr 19.
4. Lanzagorta-Aresti A, Palacios-Pozo E, Menezo Rozalen JL, Navea-Tejerina A. Prevention of vision loss after cataract surgery in diabetic macular edema with intravitreal bevacizumab: a pilot study.Retina. 2009 Apr;29(4):530-5.
5. Cheema RA, Al-Mubarak MM, Amin YM, Cheema MA Role of combined cataract surgery and intravitreal bevacizumab injection in preventing progression of diabetic retinopathy: prospective randomized study.J Cataract Refract Surg. 2009 Jan;35(1):18-25.
6. Hartnett ME, Tinkham N, Paynter L, Geisen P, Rosenberg P, Koch G, Cohen KL. Aqueous vascular endothelial growth factor as a predictor of macular thickening following cataract surgery in patients with diabetes mellitus.Am J Ophthalmol. 2009 Dec;148(6):895-901.e1. Epub 2009 Oct 17.

Endothelial dystrophy and cataract surgery

I. List the surgical complications for which the patient is at increased risk

A. Reduced visualization during surgery

B. Prolonged postoperative corneal edema

C. Corneal failure and pseudophakic bullous keratopathy

II. List steps that can be taken to reduce the operative risks

A. Minimize the amount of phacoemulsification energy expended by using techniques that minimize the ultrasound energy required to remove the lens

1. Consider using setting that limit the amount of fluid irrigated into the eye

B. Protect the corneal endothelium by working deeply in the chamber and using a retentive (either dispersive or visco adaptive) ophthalmic viscosurgical device (viscoelastic) (OVD) either alone or in combination with a "soft-shell" approach and reapplication of OVD during surgery

C. Pachymetry and endothelial cell counts may be used to help define the risk of PBK

D. Consider scleral tunnel approach vs. clear corneal incision to minimize trauma to Descemet membrane

E. The patient should be counseled about a higher risk for endothelial decompensation and a higher threshold for intervention may be chosen

F. Poor candidates for multifocal intraocular lenses (IOLs)

1. Decreased contrast sensitivity may arise from both keratopathy and IOL
2. Emmetropia less likely following a penetrating or endothelial keratoplasty, if needed in the future

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Potential for long-term corneal failure or pseudophakic bullous keratopathy despite successful cataract surgery

B. Some patients may achieve a satisfactory outcome for their needs even in the presence of early corneal edema preoperatively

C. When endothelial cell count is low, consider a mild myopic refractive aim anticipating a hyperopic shift in case Descemet stripping endothelial keratoplasty (DSEK) may be required for endothelial graft failure

IV. Are the patient instructions different (postoperative care, vision rehabilitation)?

A. The patient should be cautioned to wait three months or more after cataract surgery for corneal recovery before an endothelial transplant (DSAEK) or penetrating keratoplasty is considered

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.
3. Storr-Paulsen A, Nørregaard JC, Farik G, Tårnhøj J.The influence of viscoelastic substances on the corneal endothelial cell population during cataract surgery: a prospective study of cohesive and dispersive viscoelastics. Acta Ophthalmol Scand. 2007 Mar;85(2):183-7.

Corneal transplantation in conjunction with cataract surgery

I. List the indications/contraindications

A. Indications

1. Significant corneal disease requiring corneal grafting and cataract extraction
2. Need or desire to avoid two separate surgeries

B. Contraindications

1. The corneal disease is mild and there is a good chance that vision will be improved by cataract surgery alone
2. The cataract is mild and there is a good chance that vision will be improved by corneal grafting alone
3. The patient desires the best possible refractive outcome and does not mind the delay in final visual recovery that will occur with two separate procedures

II. Describe the pre-procedure evaluation

A. Assessment of visual disability

B. Slit-lamp biomicroscopy of the cornea showing compromised corneal clarity

1. Microcystic epithelial edema or bullae
2. Stromal thickening
3. Endothelial striae
4. Scar

C. Slit-lamp biomicroscope examination through the diseased cornea showing a visually significant cataract

D. Pachymetry may show deviation from normal corneal thickness

E. Endothelial cell count may reveal fewer than average endothelial cells

F. Complete eye exam revealing no comorbidity that would be a contraindication to surgery

G. When endothelial cell count is low, consider a mild myopic refractive aim anticipating a hyperopic shift in case Descemet stripping endothelial keratoplasty (DSEK) may be required for endothelial graft failure

III. List the alternatives to this procedure

A. Performing the two surgeries on separate occasions

IV. Describe the technique

A. Open sky technique

1. Inspect donor corneal tissue
2. Punch the donor corneal tissue and place donor button in storage media under cover on the operating table
3. Place a Flieringa ring, if indicated
4. Trephinate the diseased cornea
5. Remove the cataract by a manual technique
6. Implant the intraocular lens

7. Suture the donor cornea into place

B. "Closed" technique

1. Inspect donor corneal tissue
2. Trephinate the donor corneal tissue and place donor button in storage media undercover on the sterile side table
3. Remove the cataract by manual or phacoemulsification technique via a separate limbal incision.
4. Implant an intraocular lens
5. Trephinate the diseased cornea
6. Suture the donor cornea into place

C. Endothelial keratoplasty with phacoemulsification technique

1. Inspect donor corneal tissue (endothelial graft is often pre-prepared at eye bank with a microkeratome)
2. Remove the cataract by phacoemulsification technique via limbal or scleral tunnel incision
3. Implant an intraocular lens
4. Remove diseased endothelium
5. Insert graft via fold, glide, or injection technique
6. Float graft into position and secure with air bubble
7. Suture incision

V. Describe the follow-up care

A. Antibiotic and steroid drops postoperatively to prevent infection and graft rejection

B. Selective removal of interrupted sutures beginning approximately six months after surgery in cases requiring penetrating keratoplasty

C. Frequent refractions and changes in prescription as needed

D. IOP monitoring at appropriate intervals while steroid drops are being used.

VI. Describe appropriate patient instructions (post-op care, vision rehabilitation)

A. Patients should be instructed to seek attention if corneal foreign body sensation develops (loose or broken suture)

B. Patients should be instructed to seek attention if photophobia, conjunctival injection, or eye pain develops (graft rejection)

C. Consider rigid contact lens correction if significant irregular astigmatism is present

D. Consider refractive surgery for high ametropia after all sutures are removed

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Terry MA, et al. Endothelial keratoplasty for Fuchs' dystrophy with cataract: complications and clinical results with the new triple procedure. Ophthalmology. 2009 Apr;116(4):631-9

Cataract surgery following penetrating keratoplasty

I. List the surgical challenges for which the patient is at increased risk

A. Challenging visualization of midperiphery and periphery during surgery

B. Intraocular lens (IOL) power calculation inaccuracy

C. Low preoperative endothelial cell counts may raise the threshold for intervention. However, some have advocated addressing cataracts as soon as reasonable in this group of patients before endothelial cell counts become more compromised and lens nuclear material becomes more dense

II. List steps that can be taken to reduce the operative risks

A. Use a highly retentive (either dispersive or viscoadaptive), soft shell technique and/or ophthalmic viscosurgical device (viscoelastic) to protect the endothelium (with possible augmented administrations throughout the case)

B. Perform phacoemulsification as far from the endothelium as safely possible to avoid endothelial trauma

C. Intentional off-axis manual rotation of the globe for peripheral anterior segment visualization as needed during surgery to maintain an optimum view

D. Treat postoperative inflammation aggressively to reduce the risk of graft rejection or failure

E. In the setting of high or irregular astigmatism, determine corneal power for lens implant power calculations from corneal topography or the rigid contact lens method

F. When endothelial cell count is low, consider a mild myopic refractive aim anticipating a hyperopic shift in case Descemet stripping endothelial keratoplasty (DSEK) may be required for endothelial graft failure

G. Reduce corneal astigmatism by suture removal and/or astigmatic adjustment and allow for stabilization before measuring for IOL power

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. The presence of an opaque peripheral cornea and irregular central cornea may impair cortical clean-up, leading to accelerated posterior capsule opacification and prolonged inflammation

B. Corneal astigmatism often changes continuously for years after a penetrating keratoplasty, necessitating frequent changes in optical correction

1. Reducing corneal astigmatism and removing sutures prior to cataract surgery may mitigate this shift following cataract surgery

C. Graft rejection or failure

IV. Describe how follow up instructions and care differs from routine cataract surgery

A. The status of the donor cornea must be monitored long term for signs of endothelial failure and graft rejection

B. Remember to maintain long-term corticosteroid treatment, such that the patient does not follow a routine post-op drop taper schedule with which they may inadvertently stop corticosteroid drops altogether. Monitor IOP at appropriate intervals throughout the period of corticosteroid use

C. Patient should be instructed to seek attention if corneal foreign body sensation develops (loose or broken suture)

D. Patient should be instructed to seek urgent attention if photophobia, reduced vision, or eye pain develops (graft rejection)

E. Consider rigid contact lens correction if significant irregular astigmatism is present

F. Consider keratorefractive surgery, including LASIK, photorefractive keratectomy, astigmatic keratotomy or relaxing incisions for stable post-cataract ametropic or astigmatic refractive error

G. Consider adding (or increasing the frequency of administration of) topical corticosteroid eye drops to reduce the risk of graft rejection or failure

H. Consider perioperative treatment with oral antiviral in cases of prior Herpes Simplex infection

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. Oral acyclovir for herpes simplex virus eye disease: effect on prevention of epithelial keratitis and stromal keratitis. Herpetic Eye Disease Study Group. Arch Ophthalmol. 2000;118:1030-1036.

Cataract surgery following refractive surgery

I. List the surgical complications for which the patient is at increased risk

A. Dissatisfaction with the refractive results of cataract surgery

B. Difficulty calculating intraocular lens (IOL) implant power

1. An unintended hyperopic result is more common following both incisional and ablative myopic refractive procedures
2. An unintended myopic result is more common following ablative hyperopic refractive procedures

C. Transient hyperopic shift immediately after surgery in eyes with a history of radial keratotomy may last weeks and may fluctuate widely

D. Dehiscence of refractive keratotomy incisions

E. Increased risk of compromised quality of vision with use of multifocal presbyopia correcting IOLs

F. Edema in flap interface

II. List steps that can be taken to reduce the operative risks

A. Take steps to improve the accuracy of lens power calculation (See Intraocular lens calculation following refractive surgery)

B. Use intraoperative aberrometry to refine lens power choice, if available.

C. Avoid over-pressurizing eyes with a history of incisional keratotomy to prevent an immediate postoperative hyperopic shift in corneal power resulting from stress to the keratotomies

D. Avoid cutting into or across radial and arcuate keratotomy incisions, if possible, to avoid dehiscence

1. Consider scleral tunnel incision if radial incisions of radial keratectomy are too close together to avoid

E. Avoid crossing the interface of a LASIK flap with the keratome or astigmatic incision

F. Carefully evaluate corneal shape, including presence of higher order aberrations, prior to implanting multifocal presbyopia correcting lenses

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Inaccurate intraocular pressure measurements

B. For eyes with a history of incisional keratotomy, it may take weeks to several months to obtain refractive stability

C. If an IOL exchange is necessary, it should be performed only after refractive stability has been achieved, typically at one month or more

D. Post-myopic refractive surgery eyes may have long axial lengths

1. Advise these patients about
    a. Increased risk of retinal hole, tear, or detachment in the pseudophakic state
    b. Early warning signs of retinal detachment
    c. Urgent nature of symptoms and need for prompt ophthalmic evaluation

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 159-161.
3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Keratoconus and cataract surgery

I. List the surgical complications for which the patient is at increased risk

A. Postoperative irregular corneal astigmatism with commensurately reduced acuity or contrast sensitivity

II. List steps that can be taken to reduce the operative risks

A. Use corneal topography to determine the power of the cornea within the entrance to the pupil . Use lowest K power from central zone IOL calculations so that any post-op error is a myopic outcome

B. Toric intraocular lenses should be considered with caution, cannot correct irregular astigmatism and may complicate subsequent rigid contact lens fitting

C. Counsel the patient that a rigid contact lens may be necessary for best visual acuity after cataract surgery

D. Consider penetrating or deep anterior lamellar keratoplasty and long-term refractive stabilization before cataract surgery if indicated

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Progressive corneal ectasia may occur, resulting in a changing refraction

B. If satisfactory vision cannot be obtained with eyeglasses or contact lenses, a penetrating or deep anterior lamellar keratoplasty may be necessary subsequently

IV. Are the patient instructions different (postoperative care, vision rehabilitation)?

A. Rigid contact lens fitting should be considered if satisfactory vision cannot be obtained with eyeglasses

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Small eyes and cataract surgery

I. List the surgical complications for which the patient is at increased risk

A. Endothelial trauma (more likely with a shallow anterior chamber)

B. Iris trauma and prolapse

C. Difficulty calculating intraocular lens (IOL) implant power

D. Intraoperative suprachoroidal effusion

II. List steps that can be taken to reduce the operative risks

A. Use a highly dispersive ophthalmic viscosurgical device (viscoelastic) liberally to maintain adequate space

B. Preoperative IV mannitol or IV acetazolamide can shrink vitreous volume and allow a deeper anterior chamber working space

C. Maintain infusion bottle at a height throughout surgery sufficient to assure adequate working space, prevent hypotony and reduce the likelihood of suprachoroidal effusion

D. Make certain the corneal entry site for the cataract incision is not close to the iris root

E. Select IOL with flexible haptics and shorter overall length, based on the size of the capsular bag/anterior segment

F. Consider preoperative atropinization to reduce the risk of suprachoroidal effusion (unless contraindicated by risk of angle closure glaucoma).

G. Some have advocated a "dry" pars plana vitrectomy to create space in eyes with an extremely shallow anterior chamber

H. Calculate lens implant power using late generation power formulae

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Intraoperative iris trauma (sphincter damage, pigment epithelial layer loss, iris tear, iridodialyses or inadvertent iridotomies) may cause glare symptoms or polyopia and should be repaired if possible

B. Persistent corneal edema from endothelial trauma may necessitate lamellar keratoplasty

C. Sequelae of choroidal effusion

D. An IOL power calculation error may necessitate a lens exchange or implantation of a secondary piggyback lens

1. If a piggyback lens is used, it should be placed in the sulcus

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Wladis EJ, Gewirtz MB, Guo S. Cataract surgery in the small adult eye. Surv Ophthalmol 2006;51:153-61.
3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Surgery of dense nuclear cataracts

I. List the surgical challenges for which the patient is at increased risk

A. Little cortex to protect the capsule during phacoemulsification

B. Increased phacoemulsification time resulting in an increased risk of postoperative corneal edema

C. Greater risk of thermal and mechanical injury to the cornea and iris during phacoemulsification

D. Difficulty visualizing and performing capsulorrhexis

E. Increased risk of posterior capsule rupture

F. Increased risk of vitreous loss

G. Increased risk of dropped nucleus

H. Increased risk of iatrogenic loose zonules

II. List steps that can be taken to reduce the operative risks

A. Consider capsule staining with trypan blue or indocyanine green because it is easier to see the capsule more rapidly, should a tear or zonular dialysis occur

1. Rapid recognition may avert further damage

B. Minimize zonular stress during surgery by utilizing chopping techniques and viscodissection

C. Minimize the amount of phacoemulsification energy expended by using a pulse or burst mode and an efficient technique of nucleus disassembly. Some advocate chopping, pre-chop or nucleus softening with femtosecond laser

D. Consider modified phaco needles including angled or "Kelman" tips, tips with aspiration bypass ports, or a sharper angled tip, especially if tip clogging occurs

E. If using oscillatory (torsional) ultrasound energy, consider adding some longitudinal bursts to the power modulation to reduce line or handpiece occlusion

F. Protect the corneal endothelium by working deeply in the chamber and employing an appropriate dispersive or highly retentive ophthalmic viscosurgical device (viscoelastic)

1. Repeated instillation may be required during the procedure

G. Lower the vacuum and flow settings on the phacoemulsification machine when removing the last bit of nuclear material to prevent surge and chamber collapse, varying with the particular machine and settings.

H. Consider extracapsular cataract extraction or referral to an appropriately skilled surgeon if not comfortable with performing surgery by the phacoemulsification technique

I. Enlarge the pupil if needed and create a large capsulorrhexis to increase removal options

III. Is the follow up care different than for routine surgery?

A. Corneal edema may persist for longer than normal. If endothelial trauma has been excessive, may not resolve and may result in failure to reach anticipated visual acuity when edema is in visual axis

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Surgery of white cataracts

I. List the surgical complications for which the patient is at increased risk

A. Difficulty visualizing and performing the capsulorrhexis

B. Radial extension of the anterior capsulotomy to the periphery

C. Increased risk of posterior capsule rupture

D. Increased risk of vitreous loss

E. Increased risk of dropped nucleus

II. List steps that can be taken to reduce the operative risks

A. Enlarge the pupil if necessary for visualization and adequate capsulorrhexis

B. Stain the anterior capsule with dye (See Capsule staining)

C. Flatten the dome of the anterior capsule with adequately cohesive ophthalmic viscosurgical device (OVD) before performing the capsule puncture

D. Make a small initial opening in the anterior capsule to remove liquid cortex with the Utrata forceps or a needle, then add additional OVD into the anterior chamber, if necessary, prior to completing the capsulorrhexis.

E. Some make a small capsulorrhexis to maintain control and then enlarge it prior to nuclear disassembly

F. Control the egress of viscoelastic by choice of OVD and incision size to prevent anterior chamber shallowing during capsulorrhexis

III. Unknown visual prognosis

A. Even in the presence of B-scan ultrasound assessment of posterior segment in advance of surgery, the structure can be evaluated but the visual prognosis is still unknown. The patient should be counseled on this

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Management of small pupil

I. Describe why it is necessary for the surgeon to be able to manage pupil size intraoperatively

A. Increases visualization of operative field

B. Allows a normal sized capsulorrhexis to be more easily achieved

C. Allows for easier and more complete cortical clean-up.

D. Reduces complications

1. Small pupil capsule rupture
2. Vitreous loss
3. Limits iris trauma

II. Describe what size pupil is too small for cataract removal

A. Operator dependent - surgical skill and necessary pupil size are often inversely related

B. Must be large enough to allow instruments in and insertion of intraocular lens

III. List the preoperative factors or conditions that might result in a small pupil

A. Pseudoexfoliation

B. Chronic miotic therapy

C. Diabetes mellitus

D. Synechiae from previous inflammation

E. Systemic medications affecting mydriasis

1. Oral agents associated with intraoperative floppy iris syndrome (IFIS)
2. Opioids

F. Idiopathic

IV. List the options the surgeon has to enlarge the pupil describing the techniques and complications of each

A. Preoperative

1. Pharmacologic
    a. Pledget soaked with dilating agents placed in inferior conjunctival cul-de-sac
    b. Topical phenylephrine 10% drops
        i. May result in rise in blood pressure

B. Intraoperative

1. Injection of diluted preservative-free epinephrine or phenylephrine
    a. Toxic anterior segment syndrome if not prepared with balanced salt solution
2. Ophthalmic viscosurgical device (viscoelastic) instillation
    a. May result in increased intraocular pressure postoperatively
3. Mechanical hooks/pupil rings
4. Stretching, one or two handed - contraindicated in IFIS

a. Iris sphincter tears and bleeding

b. Aesthetic malformation due to synechiae

5. Lysis/stripping of iris/pupillary adhesions

a. Mild bleeding

b. Loss of pigmented pupillary collar

6. Multiple sphincterotomies

a. Postoperative mydriasis

b. Nonfunctional pupil if cuts made to large

V. Describe why an initially adequate sized pupil might become miotic during surgery

A. Iris stimulation of any cause, instruments, fluids, turbulence, intermittent shallowing and deepening of anterior chamber (AC) with release of prostaglandins

B. Inadequate preoperative dilation

C. Femtosecond laser techniques may stimulate miosis due to dispersion of light and energy into the eye

VI. Management of a miotic pupil

A. Preoperatively

1. Prevent by using topical non-steroidal anti-inflammatory drugs (NSAIDs)

B. Intraoperatively

1. Epinephrine added to irrigation solution or injected into AC intraoperatively

2. Avoid iris stimulation from instruments or from multiple variations in AC depth as fluidics change

3. Use second instrument to physically hold iris away from working area

4. Stop and insert iris hooks

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Cataract surgery following a glaucoma filtering procedure

I. Describe how the high-risk characteristic or comorbidity affects the surgical condition

A. Glaucoma filtration surgery may

1. Accelerate cataract development
2. Cause the development of anterior or posterior synechiae
3. Be associated with a large iridectomy
4. Be associated with the presence of an intraocular drainage tube
5. Be associated with weak zonules

B. Eyes with glaucoma often dilate poorly because of previous miotic therapy, pseudoexfoliation syndrome, neovascularization of the iris or posterior synechiae

C. Presence of filtration bleb may require alternate location for surgical incisions.

II. List the surgical complications for which the patient is at increased risk

1. Increased filtration through the bleb or drainage device during surgery
2. Postoperative hypotony
3. Higher intraocular pressure (IOP) during the first postoperative week (or longer)
4. Decreased filtration or bleb failure following surgery and long-term loss of IOP control
5. Zonular damage
6. Damage to integrity of filtration bleb causing leak and increasing risk of endophthalmitis

III. List steps that can be taken to reduce the operative risks

A. Assure adequate dilation for safe surgery

B. Avoid making the cataract incision near the glaucoma filter or drainage device

1. It may be preferable to place the incision in the clear cornea and avoid incising the conjunctiva and Tenon capsule

C. Minimize postoperative inflammation by appropriate use of anti-inflammatory agents. Steroid drops are often used with more frequency and longer term in the setting of a functioning glaucoma filter to reduce the chance of fibrosis and late bleb failure

D. Avoid zonular stress during surgery

E. Conjunctival sparing incisions are ideal

F. The incision should be sutured at the conclusion of the case to prevent hypotony. A suture also offers protection from decompression of the globe in cases where digital massage is needed to address IOP spikes or bleb failure.

G. Avoid over-pressurizing the eye at the conclusion of the case to avoid bleb rupture

IV. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. The long-term results are determined primarily by the course of glaucoma

B. Most glaucoma filters and Setons lose effectiveness over time

C. IOP must be monitored on an ongoing basis

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

Cataract surgery combined with glaucoma filtering procedure

I. List the indications/contraindications

A. Indications

1. Visually significant cataract
    a. Poorly controlled intraocular pressure (IOP) on multiple medications
    b. Well controlled IOP on maximal tolerable medications, but a desire to reduce dependence on glaucoma medications
    c. Poor medication compliance
2. The need to minimize operative and anesthetic risks and the time to final visual recovery associated with two separate procedures
3. Controlled IOP in the presence of advanced glaucomatous damage

B. Contraindications

1. Mild or visually insignificant cataract
2. Glaucoma suspect status
3. Well-controlled IOP on one or two well tolerated topical medications

II. Describe the pre-procedure evaluation

A. Assessment of cataract by the usual methods (visual function deficit, best-corrected visual acuity measurement, glare testing, slit-lamp biomicroscopic examination, fundus examination, potential acuity)

B. Assessment of glaucoma status by the usual methods (tonometry, gonioscopy, slit-lamp biomicroscopic examination, optic nerve evaluation, visual field examination, retinal nerve fiber layer analysis)

III. List the alternatives to this procedure

A. Staged surgery

1. Glaucoma surgery first followed by cataract surgery (several studies say the long-term success of the glaucoma filter is better if surgery is staged) although some studies show that IOP is frequently higher after second stage cataract surgery
2. Cataract surgery first followed by glaucoma filtering surgery
3. Selective laser trabeculoplasty or argon laser trabeculoplasty if IOP not reduced by cataract surgery alone

B. Cataract surgery alone

1. IOP drops 2-3 mm Hg, on average, after cataract surgery

C. Cataract surgery combined with a glaucoma procedure other than trabeculectomy

1. Endoscopic laser cyclophotocoagulation
2. Trabecular electrocautery (e.g. Trabectome)
3. Trabecular micro-bypass stent
4. Viscocanalostomy
5. Glaucoma tube shunt surgery

IV. Describe the technique

A. Both procedures at same site

1. Surgery is usually performed superiorly
    a. Fornix-based conjunctival flap (limbal incision); may initially have more conjunctival wound leak
    b. Limbus-based conjunctival flap (fornix incision)
    c. Both incision types provide the same degree of long-term IOP control in combined surgery
2. Cataract surgery is performed through a sclerocorneal tunnel incision
3. After cataract removal, the tunnel is converted into a glaucoma filter

B. Procedures at separate sites

1. Glaucoma filter should be placed superiorly
    a. Fornix-based conjunctival flap (limbal incision); may initially have more conjunctival wound leak
    b. Limbus-based conjunctival flap (fornix incision)
    c. Again, both incision types provide the same degree of long-term IOP control in combined surgery
2. Phacoemulsification incision can be placed temporally or superiorly
    a. Consideration should be given to suturing the 'self-sealing' incision due to potential of hypotony from the filter adversely affecting the 'self-seal'
3. The cataract operation is usually performed first

C. Adjunctive therapy in combined cataract and glaucoma surgery

1. Mitomycin C is beneficial in further lowering IOP

V. List the complications of this procedure, their prevention and management

A. All the usual risks of cataract surgery

B. All the risks of glaucoma filtering surgery

1. Short-term (wound leak, hypotony, flat anterior chamber, choroidal effusions, hypotony maculopathy, aqueous misdirection, increased postoperative inflammation)
2. Long-term (increased corneal astigmatism, bleb irritation, bleb infection, late endophthalmitis, lens decentration, lens dislocation, optic capture, chronic hypotony, IOP rise, failure of the filter)

VI. Describe the follow-up care

A. Routine follow-up care as for glaucoma filtering surgery

B. Final refraction when astigmatically stable

VII. Describe appropriate patient instructions (post-op care, vision rehabilitation)

A. Special precautions with regard to postoperative eye trauma, eye rubbing, Valsalva maneuvers

B. Specific discussion on the signs and symptoms of endophthalmitis as this complication may occur years after glaucoma filtering surgery

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Tong JT, Miller KM. Intraocular pressure change after sutureless phacoemulsification and foldable posterior chamber lens implantation. J Cataract Refract Surg 1998;24:256-62.
3. Verges C, Cazal J, Lavin C. Surgical strategies in patients with cataract and glaucoma. Curr Opin

Ophthalmol 2005;16:44-52.

4. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Pseudoexfoliation and cataract surgery

I. Nature of Condition

A. Age-related disease causing deposition of fibrillar amyloid-like material throughout the anterior chamber and in other tissues of the body

B. Within the eye the fibrillar material deposits on the lens capsule, iris, ciliary body, the zonules and, rarely, the endothelium, simulating keratic precipitates

C. Demographics

1. Patients tend to be 60 years or older
2. Geographic clustering suggests a hereditary pattern.
    a. Increased risk in Scandinavians, Eastern Europeans, Russians and Ethiopians

D. Pertinent clinical features

1. Ground glass appearing concentric deposition of fibrillar material on anterior lens capsule
    a. Rings noted on the lens capsule
    b. Best viewed with dilation of pupil
2. Transillumination defect and fibrillar material at the pupillary margin
3. Loss and/or thinning of the pupillary ruff
4. Open angle with brown clumps of fibrillar material on trabecular meshwork or Schwalbe line or anterior to Schwalbe line
5. Flakes of fibrillar material on corneal endothelium
6. Evidence of zonular weakness
    a. Phaco or iridodonesis
    b. Lens subluxation or even luxation

II. List the surgical complications for which the patient is at increased risk

A. Intraoperative miosis

B. Zonular laxity or instability

C. Vitreous loss

D. Floppy iris and iris prolapse

E. Accelerated posterior capsule opacification

F. Anterior capsulorrhexis contraction or phimosis

G. Lens tilt and decentration

H. Late dislocation of the lens implant and capsular bag

I. Increased risk for postoperative intraocular inflammation and corneal decompensation due to loss of integrity of the blood/aqueous barrier

J. Increased intraocular pressure during the immediate postoperative period

III. List steps that can be taken to reduce the operative risks

A. Take appropriate steps to assure an adequate pupil size for safe cataract surgery (See Management of small

pupil)

1. Pharmacologic mydriasis
    a. Pre-operative mydriatic drops
    b. Intraoperative intracameral preservative-free lidocaine/epinephrine combination (See Topical/intracameral anesthesia)
2. Viscomydriasis (See Ophthalmic viscosurgical devices)
3. Pupil stretch, sphincterotomies, pupil hooks, and pupil ring expanders

B. Avoid excessive stress to the zonules during surgery

C. Use of an endocapsular tension ring may stabilize the capsular bag complex for the surgery. Placement of such a ring in the presence of normal appearing zonular function, but in a patient with a long anticipated life span may improve subsequent management of the patient if the intraocular lens (IOL)/bag complex decenters later in life

D. A standard capsular tension ring will NOT prevent late subluxation

E. Consider scleral fixation, iris fixation, Cionni modified capsular tension ring, Ahmed capsular tension segment, or anterior chamber lens implantation if moderate to severe zonular laxity is present

F. An overly small capsulorrhexis may increase the chances of phimosis

G. Accommodating IOLs are contraindicated as a result of their need for normal zonular function

H. Multifocal IOLs require centration and thus their long term centration should be considered

I. Consider topical anti-hypertensive drops or intracameral carbachol/acetylcholine at the conclusion of the case or postoperative acetazolamide to prevent IOP spikes

IV. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Moderate to severe zonular laxity may produce symptomatic pseudophakodonesis

B. Lens and/or capsular bag decentration may occur early or late after surgery

C. Intraocular pressure (IOP) control often improves after cataract surgery in eyes with pseudoexfoliation but early post-operative IOP spikes should be anticipated

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001.
3. AAO, Focal Points: Strategies for Complicated Lens Surgery, Module #8, 2005.
4. Shingleton B, Crandall A, Ahmed I. Pseudoexfoliation and the cataract surgeon: preoperative, intraoperative, and postoperative issues related to intraocular pressure, cataract, and intraocular lenses.J Cataract Refract Surg. 2009;35(6):1101-20.

Pterygium and cataract surgery

I. Describe the approach to establishing the diagnosis (Pterygium)

A. Describe the etiology of this disease

1. Exposure to ultraviolet light, wind, dust, dry environment
2. Elastotic degeneration and fibrovascular proliferation

B. Define the relevant aspects of epidemiology of the disease

1. More common in patients exposed to environmental elements (farmers, construction workers, sailors)
2. Males twice as common as females to get pterygium
3. Patients over 40 years have the highest prevalence of pterygia

C. List the pertinent elements of the history

1. Foreign body sensation
2. Redness
3. Possible change in vision when far advanced
    a. Induced astigmatism
    b. Encroaches on visual axis
4. May be asymptomatic

D. Describe pertinent clinical features

1. Wing-shaped growth of fibrovascular tissue arising from interpalpebral conjunctiva (nasal location most common)
2. Growth onto cornea
3. May be more injected than surrounding conjunctiva
4. May have corneal iron line (Stockers line) at head
5. May cause irregular astigmatism
6. May have dellen from drying adjacent to head
7. May be so extensive as to cause restrictive strabismus due to contraction of tissue

E. Describe appropriate testing and evaluation for establishing the diagnosis

1. Slit-lamp biomicroscopy If suspicious for neoplasm, causing irritation, or change in vision, perform excisional biopsy
2. Measure growth onto cornea (from limbus) with slit lamp reticle so progression can be documented
3. Corneal topography to assess for induced astigmatism

II. Define the risk factors

A. Sun (tropical or subtropical environment)

B. Wind

C. Dust

D. Dry environment

E. Male

III. List the differential diagnosis

A. Conjunctival intraepithelial neoplasia

B. Dermoid

C. Pannus

IV. Describe surgical therapy options for cataract surgery in the setting of a pterygium

A. If the pterygium is small and not affecting vision, cataract surgery alone can be performed

B. If the pterygium is affecting vision or astigmatism, consider removal of the pterygium alone first.

1. After the patient has healed from pterygium surgery, topography and biometry can be performed to allow more accurate IOL selection

C. Pterygium and cataract surgery can be performed simultaneously if needed in very select instances

V. List the indications/contraindications for removal of pterygium

A. Excision indicated for:

1. Lesions causing chronic irritation despite conservative measures
2. Extension approaching or into the visual axis
3. Astigmatism induction
4. Dellen formation
5. Restriction of ocular motility from symblepharon formation
6. Suspicion of conjunctival intraepithelial neoplasia
7. Aesthetic deformity

VI. Describe surgical therapy options for removal of pterygium

A. Primary closure

B. Excision with conjunctival autograft

C. Excision with application of mitomycin C 0.2 mg/ml

D. Excision with amniotic membrane graft

E. Excision with combination of amniotic membrane graft or conjunctival graft and mitomycin C

F. Sutures or fibrin tissue glue wound closure

VII. List the complications of treatment, their prevention and management

A. If cataract surgery is performed in the setting of a pterygium, there is a risk of inaccurate IOL selection due to distortion of keratometry measurements

1. Prevention
    a. Remove pterygium first, then perform keratometry and biometry after healed

B. Recurrence of pterygium after excision

1. Prevention
    a. Decrease recurrence with use of autograft or mitomycin C (MMC)
    b. Continue postoperative lubrication and corticosteroid use
2. Management
    a. Re-excise using autograft, MMC, or amniotic membrane

VIII. Describe appropriate patient instructions

A. Frequent lubrication

B. Sunglasses/UV/Wind protection

C. Careful follow-up

D. Discourage chronic use of topical vasoconstrictor

E. Postoperative antibiotic, corticosteroid, nonsteroidal anti-inflammatory drugs (NSAIDs), lubrication as indicated

F. Sunglasses for ultraviolet protection

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 4: Ophthalmic Pathology and Intraocular Tumors; Section 8: External Disease and Cornea, 2015-2016.
2. Sharma A, Gupta A, Ram J, Gupta A. Low-dose intraoperative mitomycin-C versus conjunctival autograft in primary pterygium surgery: long term follow-up. Ophthalmic Surg Lasers 2000;31:301-7.
3. Manning CA, Kloess PM, Diaz MD, et al. Intraoperative mitomycin in primary pterygium excision. A prospective, randomized trial. Ophthalmology 1997;104:844-8.
4. Chen PP, Ariyasu RG, Kaza V, et al. A randomized trial comparing mitomycin C and conjunctival autograft after excision of primary pterygium. Am J Ophthalmol 1995;120:151-60.
5. Luanratanakorn P, Ratanapakorn T, Suwan-Apichon O, et al. Randomised controlled study of conjunctival autograft versus amniotic membrane graft in pterygium excision. Br J Ophthalmol 2006;90:1476-80.
6. Frucht-Pery J, Raiskup F, Ilsar M, et al. Conjunctival autografting combined with low-dose mitomycin C for prevention of primary pterygium recurrence. Am J Ophthalmol 2006;141:1044-1050.
7. Ma DH, See LC, Hwang YS, et al. Comparison of amniotic membrane graft alone or combined with intraoperative mitomycin C to prevent recurrence after excision of recurrent pterygia. Cornea 2005;24:141-50.

High myopia and cataract surgery

I. List the intraoperative surgical complications for which the patient is at increased risk

A. Errant capsulorrhexis

B. Anterior chamber (AC) depth fluctuation from movement of the iris-lens diaphragm causing an excessively deep AC

C. Greater discomfort if surgery is performed under topical anesthesia due to iris movements

D. Difficult to accurately measure axial length if a staphyloma is present

E. Less predictable effective lens position

F. Perforation of the globe during the retrobulbar or peribulbar block

G. Wound distortion and decreased visibility if keratome incision tunnel is too long

II. List the postoperative complications for which the patient is at increased risk

A. Retinal detachment risk is increased, even with a perfect surgery, particularly in young male patients without a posterior vitreous detachment

B. An intraocular lens (IOL) implanted in the ciliary sulcus is more likely than a lens placed in the capsular bag to be unstable or decenter (because of the size of the sulcus in a highly myopic eye as compared to the haptic diameter of most lens implants)

C. Damage to iris or capsule from dynamic anterior chamber

D. Increased risk of toric IOL rotation in larger than normal capsular bag

III. List steps that can be taken to reduce the operative risks

A. Ensure adequate pressurization of AC with ophthalmic viscosurgical device (viscoelastic) during capsulorrhexis construction.

B. Use intracameral preservative-free lidocaine to reduce the discomfort associated with "reverse papillary block" in long eyes

C. Avoid incision leakage

D. Avoid repeated collapse of the anterior chamber when exiting the eye to avoid excessive distortion of the vitreoretinal interface

E. Reduce irrigation bottle height sufficiently during phacoemulsification and irrigation and aspiration so that the AC does not appear overinflated and structures are not displaced out of normal anatomic position

F. Use spatula or cannula to elevate pupil margin or to depress anterior capsule edge, providing path for irrigation fluid thus breaking the ‘reverse pupil block' which can cause an excessively deep AC

G. Carefully examine the peripheral retina before surgery to ensure retinal integrity and potentially treat any pathology that might predispose to retinal detachment postoperatively

H. Consider an IOL with a low posterior capsule opacification profile to reduce the risk of a subsequent capsulotomy (See Intraocular lens material and design and Posterior chamber intraocular lens implantation)

I. In patients at high risk for retinal detachment, avoiding a silicone IOL should be considered due to difficulties during vitreoretinal surgery

J. Attempt optic capture if haptics are place in the sulcus

IV. List steps that can be taken to reduce post-operative complications

A. Careful indirect ophthalmoscopy of the peripheral retina to check for asymptomatic retinal breaks

B. Give the patient specific information on the signs and symptoms of retinal detachment symptoms (flashes,

floaters, shadow)

V. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Unaided visual acuity may be suboptimal if there is an IOL power calculation error (most likely to occur in the setting of staphylomata)

B. Posterior capsulotomy may increase risk of retinal detachment

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Uveitis and cataract surgery

I. Describe how uveitis and its treatment might affect the lens

A. Inflammation can accelerate cataract development

B. Use of steroids, topical and systemic, can accelerate cataract development

C. Uveitis and steroid use can cause glaucoma, potentially complicating surgery

D. Uveitis can reduce endothelial cell count

II. List the surgical and postoperative complications for which the patient is at increased risk

A. Surgical

1. Small pupil requiring pupil/iris manipulation
2. Synechiolysis of posterior synechiae requiring iris manipulation
3. Weakened zonules possibly leading to zonular rupture or intraocular lens (IOL) dislocation
4. Hyphema

B. Postoperative

1. Intraocular inflammation aggravated
2. Postoperative corneal edema
3. Cystoid macular edema (CME)
4. Anterior and posterior synechiae development leading to glaucoma, secluded pupil, iris bombe, or pupil capture behind part of IOL optic
5. Posterior capsular opacification
6. Elevated intraocular pressure (IOP)
7. Corneal or Scleral melt
8. IOL removal due to effects of inflammation, e.g. cyclitic membrane, unresponsive low grade inflammation, synechiae, hypotony and maculopathy
9. Hypotony
10. Phthisis bulbi

III. List steps that can be taken to reduce intra- and post-operative risks or complications

A. Control intraocular inflammation several months before surgery

B. Control associated complications pre operatively, e.g. glaucoma, CME

C. Use of topical anti-inflammatory agents preoperatively

D. Consider systemic immunosuppressives if needed

E. Consider intraocular or subtenon steroid injections intraoperatively as indicated

F. Dissect synechiae to expose needed amount of cataract to facilitate removal

G. Enlarge pupil if needed with the minimum iris manipulation and trauma required for safe surgery with ophthalmic viscosurgical device (viscoelastic), sphincterotomies or expansion devices

H. If red reflex too poor use capsular dye

I. If zonular weakness present, consider capsular tension ring

J. Remove all cortex

K. Choose IOL design and material suitable for intended placement location

L. In children consider posterior capsulotomy and anterior vitrectomy

M. Maintain control of post op inflammation

N. Monitor for higher incidence complications, i.e. posterior capsule opacification, glaucoma, CME, iritis recurrence; higher frequency of post-operative visits

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, p. 58.
3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Patients with retinal comorbidities and cataract surgery

I. Describe how the high-risk characteristic or comorbidity affects the surgical condition

A. Some retinal diseases are associated with premature cataract development (retinitis pigmentosa (RP), diabetic retinopathy (DR), vitreoretinal surgery, intravitreal injections)

B. Reduced visual potential

II. List the surgical complications for which the patient is at increased risk

A. Age-related macular degeneration (AMD)

1. Choroidal neovascularization and sequelae, by natural history (studies are conflicting whether cataract surgery accelerates disease)
2. Reduced contrast sensitivity with the use of multifocal IOLs, particularly in patients with geographic AMD or patients significant risk of developing AMD in their estimated lifetime

B. RP

1. Zonular laxity
2. Postoperative macular edema
3. Capsular phimosis
4. Robust and rapid development of posterior capsule opacification
5. Diplopia due to inability to fuse small central islands of vision in advanced RP
6. Negative impact of contrast sensitivity reduction with the use of multifocal IOLs

C. Post-scleral buckling procedure

1. Increased axial myopia
2. Conjunctival scarring
3. Refractive surprise due to inaccurate estimation of effective lens position

D. Post-vitrectomy

1. Anterior chamber depth fluctuation during surgery (LIDRS = len- iris diaphragm retropulsion syndrome)
2. Possible posterior capsule weakness/defect/scarring
3. Zonulopathy

E. Diabetic retinopathy

1. Worsening of retinopathy
2. Clinically significant macular edema (CSME)
3. Poorly dilating pupil
4. Hyphema if neovascularization of the iris present
5. Potential negative impact of contrast sensitivity reduction with the use of multifocal IOLs in patients with history of CSME or significant laser treatment

III. List steps that can be taken to reduce the operative risks

A. Topical anesthesia may be challenging in cases with limited macular fixation

B. AMD

1. Identify and treat occult subretinal neovascularization preoperatively

C. RP

1. Consider capsular tension ring placement if focal zonular weakness encountered
2. Minimize light exposure
3. Avoid small capsulorrhexis
4. Prompt postoperative laser treatment for anterior capsular phimosis

D. Scleral buckling

1. Extra attention should be given to avoid the scleral buckle or long globe with orbital blocks.
2. Adjustments to intraocular power selection should be considered

E. Post-vitrectomy

1. Minimize wound leak
2. Lower infusion bottle height during phacoemulsification
3. If capsule defect is suspected, avoid hydrodissection

F. DR

1. Pretreat clinically significant diabetic macular edema
2. Consider advantages versus risks of a combined approach with vitrectomy surgeons if vitreous hemorrhage or proliferative diabetic retinopathy is present and cannot be treated before cataract surgery
3. Avoid multifocal lenses in patients with significant macular disease.
4. Consider pretreating with non-steroidal anti-inflammatory drugs (NSAIDs) and/or topical corticosteroids and continue each treatment longer for patients with history of CSME

IV. List the implications of the high-risk characteristic or comorbidity on the long term surgical results

A. With progressive retinal diseases, there is a potential for long-term worsening of vision despite successful cataract surgery

V. Is the follow up care different than for routine surgery?

A. Patients with retinal comorbidity may require more frequent monitoring for macular edema, especially in RP or CSME and prolonged anti-inflammatory treatment

B. RP patients may take months to achieve their maximal acuity

VI. Are the patient instructions different (post-op care, vision rehabilitation)?

A. Patients with advanced comorbidity may benefit from low vision rehabilitation services

B. Patients with significant postoperative anisometropia may need contact lenses or refractive surgery

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Patel JI. Is cataract surgery a risk factor for progression of macular degeneration? Curr Opin Ophthalmol 2007;18:9-12.

Patients with silicone oil and cataract surgery

I. List the surgical complications for which the patient is at increased risk

A. Ultrasound biometry can create axial length error if not adjusted for velocity of sound in silicone oil

B. Optical biometry is more accurate and should be used when possible

C. IOL power may need to be adjusted when silicone oil is retained long term

D. Silicone oil leak during surgery

E. Transient or persistent corneal edema, especially if silicone oil has migrated into the anterior chamber

II. List steps that can be taken to reduce the operative risks

A. Delay cataract surgery until after the silicone oil is removed

B. Avoid silicone lenses in eyes with silicone oil

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

A. Increased difficulty performing a laser capsulotomy and repeated closure of capsulotomy

B. Silicone oil adherence to the lens implant (greatest with silicone lenses) and blurred vision after a laser capsulotomy

C. Significant myopic shift, averaging 3 to 5 diopters, if a lens implant is chosen for emmetropia and the silicone oil is subsequently removed

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. AAO, Cataract Surgery and Intraocular Lenses, 2nd edition, 2001, p. 155-156,168-169.
3. AAO, Focal Points: Strategies for Complicated Cataract Surgery, Module #9, 2005.

Capsular tension rings (CTR)

I. List the indications and contraindications

A. Indications

1. FDA approved for cases of weak or partially absent zonules
2. Used in cases of known or suspected zonular defects or laxity
3. Useful in both stable zonular defects (e.g. following trauma) or in potentially progressive zonular defects (e.g. pseudoexfoliation, retinitis pigmentosa, uveitis, Marfan)

B. Contraindications

1. Capsule defect

C. Special rings

1. Modified capsular tension rings with eyelet to suture to sclera (e.g. Cionni ring)
2. Henderson CTR with waves in ring allows cortical material to be removed when placed early
3. Ahmed capsular tension segment (CTS) is a partial ring with eyelet to suture to sclera and support a section of the capsular bag

II. Describe the pre-procedure evaluation

A. Clock hours of zonular weakness

B. Presence of phacodonesis

C. Presence of vitreous prolapse

D. Identification of risk factors such as pseudoexfoliation, Marfan s syndrome, trauma history, etc.

III. List the alternatives to the procedure

A. Iris or scleral fixation of intraocular lens (IOL)

B. Anterior chamber IOL placement

C. Aphakia with spectacle correction

IV. Describe the instrumentation, anesthesia and technique

A. Instrumentation

1. Injector
2. Viscoelastic

B. Anesthesia

1. Children - general anesthesia
2. Adults - topical / local infiltration anesthesia

C. Technique

1. Ring in capsular bag either with an injector or manually
2. Before or after phacoemulsification
3. Can be sutured to the sclera in case of a greater degree of subluxation (e.g. Cionni ring)

V. List the complications of the procedure, their prevention and management

A. Intra-operative

1. Extension of zonular dialysis or capsular tears
2. Dislocated ring
3. Inadvertent sulcus placement

B. Postoperative

1. Late decentration or dislocation of the IOL/ring/capsular bag complex

C. Prevention of complications

1. Intra-operative
    a. Continuous curvilinear capsulorrhexis
    b. Safety suture secured through one eyelet of ring to allow retrieval
2. Postoperative
    a. Late decentration of IOL/ring/capsular bag complex:
        i. Suture fixation to sclera

VI. Describe the follow up care

A. Monitor intraocular pressure

B. Retinal evaluation for detachment and cystoid macular edema

C. Look for IOL/ring/capsular bag complex tilt and decentration

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.
2. Hasanee K, Butler M, Ahmed II. Capsular tension rings and related devices: current concepts. Curr Opin Ophthalmol 2006 17(1):31-41
3. Cionni RJ, Osher RH, Marques DM, et al. Modified capsular tension ring for patients with congenital loss of zonular support. J Cataract Refract Surg 2003;29:1668-1673.
4. Menapace R, Findl O, Georgopoulos M, et al. The capsular tension ring; designs, application, and techniques. J Cataract Refract Surg 2000;26:898-912.

Instrumentation and adjustments for intraoperative floppy iris syndrome

I. List the surgical challenges for which the patient is at increased risk

- **A.** Iris prolapse
- **B.** Iris billowing
- **C.** Progressive miosis
- **D.** Iris sphincter damage/irregular pupil
- **E.** Iridodialysis
- **F.** Hyphema
- **G.** Corneal edema
- **H.** Retained lens material
- **I.** Posterior capsule (PC) rupture
- **J.** Zonular damage
- **K.** Malpositioned intraocular lens (IOL) or haptics due to poor peripheral visualization

II. List steps that can be taken to reduce the operative risks

- **A.** Use of stronger, targeted mydriatic agents such as intracameral phenylephrine, epinephrine, and/or topical atropine
- **B.** Careful incision architecture
- **C.** Gentle hydrodissection
- **D.** Alter machine settings for slower fluid exchange
- **E.** Use of iris expansion devices to maintain the pupil
- **F.** Adequate ophthalmic viscosurgical device (viscoelastic)

III. List the implications of the high-risk characteristic or comorbidity on the long-term surgical results

- **A.** Increased glare or photophobia with iris damage/transillumination
- **B.** IOL centration/positioning issues
- **C.** Corneal edema
- **D.** Increased post-operative inflammation
- **E.** Elevated intraocular pressure
- **F.** Cystoid macular edema

IV. Describe how follow up instructions and care differs from routine surgery

- **A.** Prolonged steroidal or nonsteroidal anti-inflammatory drug (NSAID) drop may be indicated in those with iris damage or excessive intraocular inflammation
- **B.** Intraocular pressure lowering medications may be required in those with moderate to severe pressure spikes

Additional Resources

1. AAO, Basic and Clinical Science Course. Section 11: Lens and Cataract, 2015-2016.

2. ASCRS White Paper: clinical review of intraoperative floppy-iris syndrome. Chang DF, Braga-Mele R, Mamalis N, Masket S, Miller KM, Nichamin LD, Packard RB, Packer M; ASCRS Cataract Clinical Committee. J Cataract Refract Surg. 2008 Dec;34(12):2153-62.

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Cataract/Anterior Segment

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