Glaucoma Surgery – Where Do We Stand?
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Disclosures

1.) I am on the Speakers Bureau for Alcon Laboratories, Inc.

2.) I will not be discussing the unlabeled use of commercial products or the investigational use of commercial products not yet approved by the U.S. FDA.
Glaucoma - Definition

- A group of diseases that have in common a characteristic optic neuropathy and associated visual field loss for which elevated intraocular pressure (IOP) is one of the primary risk factors.

Glaucoma as a Medical Science

Classification of Glaucoma

- Open-Angle Glaucomas:
  - Primary Open-Angle Glaucoma
  - Normal-Tension Glaucoma
  - Congenital Glaucoma
  - Axietity Open-Angle Glaucoma
  - Pigmentary Glaucoma
  - Pseudoexfoliation Glaucoma
  - Phacolytic Glaucoma
  - Phacophotographic Glaucoma
  - Inflammatory Glaucoma (open)
  - Ghost Cell Glaucoma
  - Herpetiform Glaucoma
  - Steroid-Induced Glaucoma
  - Angle-Recession Glaucoma
  - Glaucoma Associated w/ Elevated Episcleral Venous Pressure
  - Glaucoma Associated w/ Intraocular Tumors
  - Glaucomatocyclitic Crisis
  - Fuchs Hemorrhagic Iridocyclitis

- Angle-Closure Glaucomas:
  - Acute Angle-Closure Glaucoma
  - Intermittent Angle-Closure Glaucoma
  - Chronic Angle-Closure Glaucoma
  - Plateau Iris Syndrome
  - Phacomorphic Glaucoma
  - Aphakic Angle-Closure Glaucoma
  - Neovascular Glaucoma
  - Inflammatory Glaucoma (closed)
  - Malignant Ciliary Block Glaucoma
  - Fuchs Hemorrhagic Iridocyclitis
  - Iridoendothelial (ICE) Syndrome
  - Epithelial Downgrowth
Pseudoexfoliation Glaucoma

Pigmentary Glaucoma

Inflammatory (Uveitic) Glaucoma
Iridocorneal Endothelial (ICE) Syndrome w./ Glaucoma

Glaucoma - Definition

- A group of diseases that have in common a characteristic optic neuropathy and associated visual field loss for which elevated intraocular pressure (IOP) is one of the primary risk factors.

Glaucoma - Epidemiology

- Approximately 3 million Americans suffer from Glaucoma
- Approximately 69 million people worldwide suffer from Glaucoma
- More than 130,000 Americans are legally blind from the disease
- Major Risk Factors:
  - Older Age (60 + yrs.)
  - Black and Hispanic Race
  - Positive Family History
Glaucoma – Mechanism of Disease

Trabecular Meshwork Outflow Pathway

Glaucoma – Mechanism (Trabecular Meshwork Outflow)

Gonioscopy of Anterior Chamber Angle

Glaucoma – Clinical Diagnosis and Monitoring

- Intraocular Pressure (IOP)
  - Mean Population IOP: 16 mm Hg (SD ± 3)
  - Clinical Range of Normal: 8 – 22 mm Hg

- Optic Nerve Appearance

- Visual Field
Optic Nerve Appearance

- Normal
- Advanced Glaucoma

Visual Field Assessment

Humphrey Visual Field

Visual Field - Normal

- Left Eye
- Right Eye
Glaucomatous Field Loss (Mild – Moderate) – Right Eye

Glaucomatous Field Loss (Advanced) – Left Eye

Visual Field Loss – Advanced (End-Stage)
Glaucomatous Field Loss – Over Time

How Is Glaucoma Treated?

• I.) Medical Therapy (Drops and Pills)
• II.) Laser Treatment
• III.) Surgery

Glaucoma - Medical Therapy
Glaucoma – Drop Therapy

• Beta Blockers:
  – Timolol (Timoptic, Timoptic XE, Betimol, Maxalt)
  – Betaxolol (Betoptic S)
  – Metipranolol (OptiPranolol)
  – Levobunolol (Betagan)

• Miotics:
  – Pilocarpine (1% - 4%)
  – Echothiophate iodide (Phospholine iodide)

• Carbonic Anhydrase Inhibitors:
  – Brinzolamide (Azopt)
  – Dorzolamide (Trusopt)

• Alpha-2 Agonists:
  – Brimonidine (Alphagan, Alphagan-P)
  – Apraclonidine (Iopidine)

• Prostaglandin Analogues:
  – Latanoprost (Xalatan)
  – Travoprost (Travatan)
  – Bimatoprost (Lumigan)

• Combination Agents:
  – Dorzolamide/Timolol (Cosopt)
  – Brimonidine/Timolol (Combigan)

Laser Treatment

• Argon Laser Trabeculoplasty (ALT)

• Selective Laser Trabeculoplasty (SLT)

Laser Trabeculoplasty

[Diagram of laser trabeculoplasty process]

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Glaucoma Surgery

When Should Glaucoma Surgery Be Performed?

- Intraocular Pressure Too High Despite Maximal Medical Therapy
- Progression of Field Loss and/or Optic Neuropathy
- Medical Therapy Not Tolerated (Side Effects)
- Laser Therapy Ineffective ("Burn Out")

Trabeculectomy (Filtration) Surgery

- Most commonly performed glaucoma surgery
- First Described in 1968 (Cairns JD)
- Objective: to divert aqueous outflow through a surgical fistula into subconjunctival space
- Modulation of Wound Healing:
  - Mitomycin C (MMC)
  - 5-Fluorouracil (5-FU)
Trabeculectomy

1968 Paper

Trabeculectomy Surgery - Schematic

Caims Version - 1968  Contemporary Rendition

Trabeculectomy – Surgical Sequence
Conjunctival Dissection (Limbal-Based)

Creation of the Scleral Flap

Internal Sclerostomy
Surgical Iridectomy

Trabeculectomy – Instrument Layout

- Lieberman Lid Speculum
- .12 Forceps
- Conjunctival Forceps (Non-Toothed)
  - Anatomical Forceps
  - Fechner Forceps
- Wescott Tenotomy Scissors (Blunt-Tip)
- Vannas Scissors
- Kelly Descemet's Punch
- Beaver Blade (# 69)
- Castroviejo Caliper
- Barraquer Needle Holder
- Tying Forceps (straight and curved)
- Eraser Cautery

Trabeculectomy Layout

- Suture Material:
  - 6-0 Vicryl
    - Traction Suture
  - 10-0 Nylon
    - Scleral Flap
  - 9-0 Vicryl or 9-0 Nylon
    - Conjunctival Closure
- Antimetabolite:
  - Exposure Time = 1.5 – 5 min.
  - Delivery System:
    - cut-up Weckcel sponges
    - corneal shield (1/2's)
  - Mitomycin C (MMC)
    - 0.1 – 0.5 mg/ml
  - 5-Fluorouracil (5-FU)
    - 50 mg/ml
Trabeculectomy – Postoperative Care

- Fourth-Generation Fluoroquinolone (Zymar or Vigamox):
  - 4x/day for 2 wks.
- Prednisolone Acetate (EconoPred; PredForte):
  - 8x/day for 2 wks.
  - 6x/day for 2 wks.
  - 4x/day for 2 wks.
  - 3x/day for 2 wks.
  - 2x/day for 2 wks.
  - 1x/day for 2 wks.
Trabeculectomy – Postoperative Complications

"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the "Are you totally lost?" icon."

Flat Anterior Chamber (Overfiltration – Pressure Too Low)

Requires Intervention Within 24 hrs.

Serous Choroidal Effusions (Overfiltration – Pressure Too Low)

Fundus Photo – Left Eye
Ultrasound (B-Scan) – Left Eye
Hyphema

Cataract Formation

Suprachoroidal Hemorrhage
Late-Onset Bleb Leak

- Thin, Cystic, Ischemic Bleb
- Fluorescein Dye Test: Seidel-Positive Leak

Hypotony (Chronically Low IOP)
Maculopathy

- Fundus Photo
- Fluorescein Angiogram

Blebitis (Late-Onset Infection)
Bleb-Related Endophthalmitis (Late-Onset Infection)

Glaucoma Drainage Device (Seton) Surgery

Glaucoma Drainage Device (GDD)
- GDD’s shunt aqueous to a site posterior to the limbus
- Tube placed into the anterior chamber or through pars plana
- Plate acts as an extracocular reservoir
- Indications:
  - Failed Prior Trabeculectomy
  - Active Inflammation (Uveitis)
  - Neovascular Glaucoma
  - Scared / Inadequate Conjunctiva (prior trauma, retinal detachment surgery, etc.)
Ahmed Glaucoma Valve

Other Glaucoma Drainage Devices (GDD’s)

Glaucoma Drainage Device (GDD) Implantation
Contemporary Adult Glaucoma Drainage Devices (GDD’s)

<table>
<thead>
<tr>
<th>Shunt Design:</th>
<th>Year of Introduction</th>
<th>Plate Size</th>
<th>Resistance Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molteno</td>
<td>1979</td>
<td>135 mm²</td>
<td>None</td>
</tr>
<tr>
<td>Baerveldt</td>
<td>1990</td>
<td>350 mm²</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250 mm²</td>
<td></td>
</tr>
<tr>
<td>Krupin</td>
<td>1990</td>
<td>180 mm²</td>
<td>Slit Valve</td>
</tr>
<tr>
<td>Ahmed</td>
<td>1993</td>
<td>184 mm²</td>
<td>Venturi Valve</td>
</tr>
</tbody>
</table>

Ahmed Valve Implantation – Surgical Technique (Anterior)

- Tube inserted 1.0 – 1.5 mm posterior to corneal limbus
- Plate sutured to episclera approx. 9 mm posterior to limbus

Ahmed Glaucoma Valve (Anterior Placement)

- Six Months Post Surgery
Ahmed Valve Implantation – Posterior (Pars Plana) Placement

Tube inserted at pars plana (3.5 mm posterior to corneal limbus)

Ahmed Glaucoma Valve (Anterior vs. Posterior Placement)

• Surgical Success (Final Follow-Up):
  – Anterior Group = 83.9%
  – Posterior Group = 83.9%

• Complication Profile:
  – Similar in Both Groups
Postoperative Complications – Tube Obstruction

- Iris Incarceration
- Vitreous Incarceration

Postoperative Complications – Corneal Decompensation

- Failed Corneal Graft (PK)
- Focal Corneal Edema and Folds

Postoperative Complications – Implant Erosion

- Iris Incarceration
- Vitreous Incarceration

- Failed Corneal Graft (PK)
- Focal Corneal Edema and Folds

- Iris Incarceration
- Vitreous Incarceration

- Failed Corneal Graft (PK)
- Focal Corneal Edema and Folds
New Glaucoma Surgical Innovations

Microinvasive Glaucoma Surgery (MIGS)

- ExPRESS Glaucoma Filtration Device (Alcon Laboratories, Inc)
- Trabectome (Neomedix Corporation)
- Canaloplasty
- iStent Trabecular Micro-Bypass (Glaukos Corporation)
ExPRESS Glaucoma Device

ExPRESS Glaucoma Device

ExPRESS Device - Implantation
Under Partial-Thickness Scleral Flap
ExPRESS Miniature Glaucoma Implant

ExPRESS Trabeculectomy vs. Standard Trabeculectomy

ExPRESS Glaucoma Device vs. Standard Trabeculectomy
ExPRESS vs. Standard Trabeculectomy – IOP Control

Intraocular Pressure (IOP) over Time

ExPRESS vs. Standard Trabeculectomy - Complications

Choroidal Effusions

Canaloplasty
Canaloplasty – Surgical Technique

• Dilation of Schlemm’s canal > enhances physiologic aqueous outflow
• Microcatheter Technology:
  – 200-μ-diameter, illuminated, flexible catheter threads canal
  – Viscodilates 360° circumference of canal
  – Tensioning Suture (10-0 Prolene) left behind
• Advantages:
  • Fewer complications
  • Less Follow-Up

Canaloplasty Adjunctive Surgical Procedures – Comorbid Cataract and Glaucoma/Ocular Hypertension

• Easily Combined w/ Cataract Surgery
• Ab Interno Approach
• Patient Selection:
  – Ocular Hypertension
  – Mild-Moderate Glaucoma (1-2 meds.)
• Advantages:
  – minimally invasive
  – no disruption of conjunctival tissue

Phacoemulsification of Cataract
Trabectome Surgery

- Electrosurgical ablation of Trabecular Meshwork (main site of outflow resistance)
- Ab Interno Approach (gonioscopic guidance)
- Designed to improve aqueous drainage
- Indications:
  - Mild-Moderate Glaucoma (pt. taking 1-2 meds.)

Trabectome Surgery

iStent (Trabecular Micro-Bypass)

Trabecular Stent inserted into Schlemm's canal
iStent – Surgical Technique

- **Ab Interno** procedure (gonioscopic visualization)
  - via 1.5 – 2 mm corneal incision
- self-trephinating tip inserts into trabecular meshwork
- device gently advanced into Schlemm’s canal
- inserter button is depressed and device is disengaged

Adjunctive Glaucoma Procedures – Future Potential

- Examples:
  - Trabectome (Neomedix Corporation)
  - iStent (Glaukos Corporation)
- Cataract Surgery:
  - Over 3 million cataract procedures performed each year in U.S.
- Comorbidity: Glaucoma/Ocular Hypertension
  - More than 650,000 cataract patients
- "Buzz Phrases" (Clever Marketing):
  - "short learning curve" - "safe" - "minimally invasive"
  - "widely adoptable" - "fast recovery" - "easier"
Summary – Glaucoma Surgery

- Surgery is indicated when medical and laser therapy have been exhausted
- Trabeculectomy and Glaucoma Drainage Device (GDD) surgery remain the most effective IOP-lowering procedures
- Glaucoma surgery can be fraught with sight-threatening postoperative complications
- Surgical innovations and improvements (minimal-risk) remain ongoing

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