Glaucoma is a disease of the optic nerve

Glaucoma
- A disease of the intraocular pressure (IOP)
- A disease caused by the cornea being too thin
- A disease that is always associated with a systemic condition (example diabetes)
- A disease of the optic nerve

Glaucoma Affects more than 67 million people worldwide (2000)
- 6.7 million suffering from bilateral blindness

Glaucoma is the second leading cause of blindness worldwide (cataract)
- Leading cause in blacks

Glaucoma is the first leading cause of preventable blindness
- Permanent loss of vision due to death of retinal ganglion cells and their axons
- Treatment aimed at slowing or stopping progression of damage
- Improved methods of screening and therapy for glaucoma are urgently needed

Epidemiology
- Primary open angle
  - 1.7% in Caucasians over 40
  - 5.6% in African Americans over age 40
- Ocular Hypertension
  - 7-8% in people over age 40
  - 0.5-1.0% per year develop glaucoma
- Blindness from primary open angle glaucoma
  - 6.0% Caucasians
  - 19.0% African Americans
  - 6.7 million worldwide

Classifications of Glaucoma
- Congenital
- Primary Open Angle Glaucoma
- Angle Closure Glaucoma
- Normal Tension Glaucoma
- Secondary Glaucoma
- Ocular Hypertension
Primary Open Angle Glaucoma

- 50-80%
- Physiologically abnormal intraocular pressure
- Histopathological changes in the optic nerve
- Vision loss related to optic nerve damage

Angle Closure Glaucoma

- 10%
- Iris block of angle, usually due to pupillary block

Normal Tension Glaucoma

- 14-17%
- Similar to primary open angle glaucoma except the intraocular pressure always remains below 21 mm Hg

Secondary Glaucomas

- Elevated intraocular pressure secondary to various ocular conditions
  - Pigmentary Dispersion Syndrome
  - Neovascular
    - Proliferative Diabetic Retinopathy
    - Occlusive Retinal Vascular Disease
  - Uveitis
  - Pseudoexfoliation Syndrome
  - Post Traumatic
    - Angle recession, tears and scarring in trabecular meshwork
    - Iridodialysis
  - Steroid Induced Glaucoma/Ocular Hypertension

Ocular Hypertension

- Intraocular pressure above 21 mm Hg
- No change in optic nerve
- No loss of visual function
- 10% progress to glaucoma

Characteristics of Glaucoma

- Most types of glaucoma are:
  - Bilateral
  - Asymmetric in presentation
  - Chronic in nature
  - Slowly progressive

Ocular Hypertension

- Intraocular pressure above 21 mm Hg
- No change in optic nerve
- No loss of visual function
- 10% progress to glaucoma
Glaucoma

- There is no one particular ocular finding or diagnostic test that determines or rules out glaucoma.
- The ocular findings have many variations.
  - Example: optic nerve head
    - Sloped neuroretinal rim
    - Tilted or obliquely inserted optic nerve head
    - Optic foramen size variations
- The diagnostic tests are non-specific for glaucoma and the tests themselves have limitations.
  - Example: visual field
    - Stroke, neurological deficits, retinal occlusive disease, macular degeneration
    - Reliable versus non-reliable
    - Learning curve

Risk Factors for Developing Glaucoma?

Strong associations
- Age
- The older we are the higher the risk.
- IOP
- The higher the IOP the higher the risk.
- CCT
- Thinner corneas increase risk.
- CDR
- Larger CDR increases risk.
- Race (8-9x)
- Black Americans are at higher risk.

Moderate association
- Family history
- Vascular is an issue but increases risk.

Weak associations
- Refractive Error
- Poor association.
- High myopia increases risk.
- Systemic Disease-mixed
- HTN, migraine, DM, thyroid, sleep apnea.

What is Tonometry?

Corneal Curvature
Corneal Thickness
Corneal Rigidity

Case 1

55 Year Old Men

500 microns CCT and 21 mm Hg with Goldmann

What is the true IOP?
1. 18 mm Hg
2. 21 mm Hg
3. 24 mm Hg
4. Don't Know

600 microns CCT and 21 mm Hg with Goldmann

What is the true IOP?
1. 18 mm Hg
2. 21 mm Hg
3. 24 mm Hg
4. Don't Know

Academic Answer
- Open Angle Glaucoma
- Closed Angle Glaucoma

Clinical Answer
- Those at risk to develop glaucoma.
- Those who have glaucoma but are at a higher risk of progressing.

You will see why history needs to be thorough and accurate.
Case 2

61 year old woman

- You saw her 4 weeks ago and her IOP’s were 24 OD and 25 OS at 3:35 PM
- Is in today for a morning IOP check and pachymetry

Results

- Pachymetry results
  - OD 525 OS 565
- IOP’s at 8:15 AM
  - OD 28  OS 29

Corneal Pachymetry

- Right and left eyes minimum corneal thickness differed by an average 8 μm
- 242 eyes
- Although a wide range of values exists in simulated keratometry, minimum corneal thickness, and posterior corneal elevation,
  - Interocular pachymetry symmetry in all these parameters was very high in this group of consecutive patients.
  - Asymmetry of these interocular parameters may warrant repeat clinical testing for accuracy and may predict corneal abnormalities.
  - This study points out potentially clinically important high interocular corneal symmetry data in simulated keratometry, corneal thickness, and posterior corneal elevation.

MYROWITZ Elliott H, KOUSIS Anthony C, O’BRIEN Terrence P. High interocular corneal symmetry in average simulated keratometry, central corneal thickness, and posterior corneal elevation. Optometry and vision science. 2005, vol. 82, no5, pp. 428-431
Progression

Many practitioners feel that the risk factors for developing glaucoma and the glaucoma to progress are essentially the same. However, once treatment commences things change. One obviously is IOP. Furthermore, the patients will get older and comorbidities may develop. This is where most of our evidence based medicine done (EMGTS, AGIS...)

Risk Factors for Progression of Glaucoma?

- Age
- IOP
- Diurnal IOP fluctuation
- Visual field loss
- CDR
  - The more NRR loss the higher the risk to progress
- Disc hemorrhage
  - Associated with progression
- Family history
  - Especially those with functional vision loss
- Systemic Diseases
  - DM, Migraine, HTN
- CCT
  - Not a risk of progressing in appropriately treated patients with glaucoma

Optic Nerve Head Size

- Optic nerve size is dependent on the size of scleral canal
  - Optic foramen
- Reported average optic disc area: 2.1mm² - 2.93mm²
- African Americans have larger disc areas than Caucasians

Variations of the Normal Optic Nerve Head

- Size of optic nerve head
  - Will affect cup to disc ratio
- Insertion of optic nerve head
  - Will affect appearance/slope of neuroretinal rim

Variation to Disc Diameter

- Neuroretinal rim area equal
  - 1.52 mm
    - Cup to Disc Ratio: 50% 0.5
  - 2.12 mm
    - Cup to Disc Ratio: 80% 0.8
Photos Taken at the Same Magnification

Glaucoma
Enlargement of Cup to Disc

Remember the “ISNT” rule

Violation to “ISNT” rule

Gonioscopy

Important technique for diagnosing and treating glaucoma
- Open versus closed angle
- Trauma
- Pigment
- A technique that needs practice
- Must know your anatomy

Gonioscopy

Glaucoma
Notch

Gonioscopy

Glaucoma
Notch

Optic Disc Hemorrhages

Notch, Hemorrhage and Nerve Fiber Layer Defect

Gonioscopy

Glaucoma
Notch

Gonioscopy

Glaucoma
Notch

Gonioscopy

Glaucoma
Notch

Gonioscopy

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Glaucoma
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Gonioscopy

Glaucoma
Notch
Glaucoma-Knowledge that will Help You in the Office and with Patient Care

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Less Than 18 Degrees Get Consult

"Structure versus Function"

Visual Fields
OCT Testing

Nerve Fiber Layer
Ganglion Cell Complex

Overlay of the RNFL and GCC

GCC Thinning in Glaucoma

NFL and GCC
44 year old Caucasian man

Referred for glaucoma consult due to increased IOP's and suspicious neuro-retinal rim
- 26/05 at 8:05 AM
- Systemic meds: Zyrtec (seasonal allergies)
- Family history: father with advanced glaucoma and sister with pigmentary glaucoma
- VA: 20/20 OU
- Slit lamp exam: normal
- IOP: 26 OU at 8:10 AM
- Gonios: angle open 360 to ciliary body, pigment normal
- Pach: 569/565
- Let’s look at the optic nerves.

Optic Nerves

Primary open angle glaucoma
Return for PM IOP before starting treatment
25 OU at 4:30 PM
Xalatan started
1 gtt OU QD
Return for IOP and visual field in 2-3 weeks

3 weeks later
- Patient reports redness and irritation with drops
- Good compliance with drops
- VA 20/20 OU
- IOP 18 OU at 9:40 AM (target ≤ 18)
- Visual fields completed, let’s take a look

Visual Fields

Review
- Diagnosis: Primary Open Angle Glaucoma (POAG)
- Target IOP achieved
- Reminded patient glaucoma can lead to vision loss and blindness
- Continue Xalatan, 1 gtt QD OU
- Added Systane Ultra, QID/PRN
- Return 3 months for IOP check
Case 4

66 year old Caucasian woman

- Referred for glaucoma evaluation due to increased intraocular pressures
- Brother has glaucoma
- Systemic medication: Premarin
- Intraocular pressures
  - OD 26 mm Hg at 3:00 pm
  - OS 36 mm Hg at 3:00 pm
- Gonioscopy: open OU
- Pachymetry
  - OD 557 microns
  - OS 551 microns

Anything suspicious here?

Greg’s Clinical Hint

- Asymmetric Intraocular Pressures
  - Angle recession: history of trauma or surgery
  - Pigmentary Glaucoma
  - Iris transillumination
  - Krukenberg spindle
  - Heavily pigmented trabecular meshwork
  - Pseudoexfoliation Syndrome
  - Steroid induced glaucoma

Pseudoexfoliation of the Lens

Treatment/Discussion

- ½% Betimol (Timolol) qd OU in the morning
  - OD 19 OS 25 (initial OD 28 OS 38)
- Xalatan qd OU in the evening
  - OD 12 OS 14, adequate pressures
Glaucoma Treatment

- Goal: to lower the IOP
  - IOP lowering is the only treatment for glaucoma

- Treatments
  - Pharmaceuticals
  - Laser: SLT/ALT
  - MIGS: Micro Invasive Glaucoma Surgery
  - Trabeculectomy
  - EX-PRESS glaucoma shunt (Alcon)
  - Shunts/valves
  - Cyclophotocoagulation

Lower the IOP

- Decrease aqueous production
- Increase outflow

Pharmaceuticals for Glaucoma

- Prostaglandins
- Beta blockers
- Carbonic Anhydrase Inhibitors
- Adrenergic Agonists
- Cholinergic Agonists (miotics)

Prostaglandin Analogs

- Effective (30% reduction)
  - Primary drug of choice
- Excellent systemic safety profile
- QD dosing
Ocular Side Effects of Prostaglandins

- Common
  - Iris color change
  - Eyelash growth
  - Periorbital skin darkening
- Reported side effects and contraindications
  - Cystoid macular edema (CME)
  - Ocular inflammation exacerbation
    - Uveitis
  - Herpes simplex keratitis
  - Skin rash
  - Migraine trigger

Beta Blockers (Beta Adrenergic Antagonist)

- Decrease aqueous production

Beta Blockers

- Non-Cardioselective
  - BI and B2
  - Careolol (Ocupress) 1.0%
  - Levobunolol (Betagan) 0.25% & 0.50%
  - Metipranolol (Optipranolol) 0.3%
  - Timolol solution (Timotic, Betimol) 0.25% & 0.50%
  - Timolol gel (Timoptic XE) 0.25% & 0.50%

- Cardioselective
  - BI
  - Safer in COPD
  - Not as effective as non-cardioselective
  - Betaxolol
    - Betoptic-S 0.25%
    - Betoptic 0.25% & 0.50%

Beta Blocker

- Recommend baseline (prior to starting treatment)
  - Pulse
  - Blood pressure

- Dosing QD or BID

Beta Blockers

- Contraindications
  - Cardiovascular disease
  - Heart block
  - Low blood pressure (<100/60)
  - Low pulse (<60)
  - Asthma
  - COPD
  - Emphysema

- Reported Side Effects
  - Systemic
    - Decreased pulse
    - Hypotension
    - Syncope
    - Asthma
    - Dizziness
    - Cardiac arrhythmia
    - Nasal, diarrhea
    - Anxiety, depression
    - Impotence
  - Ocular
    - Burning
    - Hyperemia
    - Punctate keratitis
    - Corneal hypoaesthesia
Topical Carbonic Anhydrase Inhibitors

- Important alternative, especially with prostaglandins
- Dorzolamide (Trusopt) 2.0%
- Brinzolamide (Azopt)

Oral Carbonic Anhydrase Inhibitors

- Use after topical and medical treatment have failed
- Acetazolamide (Diamox) 250mg, 500mg (Sequel)
- Methazolamide (Neptazane) 25mg, 50mg

- Decreases aqueous production by slowing the production of bicarbonate in epithelial cells of the ciliary body

Clinical Pearl: In angle closure glaucoma use 250mg x 2 Diamox, avoid 500mg Sequel

Reported Side Effects (Mainly Oral)

- Cross sensitivity to Sulfa drugs
- Diarrhea
- Nausea and vomiting
- Anaesthesia
- Paraesthesia
- Malaise
- Fatigue
- Loss of libido
- Metallic taste
- Bone marrow toxicity
- Kidney lithiasis
- Anemia

Adrenergic Agonists

Alpha and Beta receptor stimulation promotes increased TM outflow and uveoscleral outflow. Not totally understood.

- Dipivefrin (Propine) 0.1%
  - Replaced by Alphagan-P
- Apraclonidine (Iopidine) 0.5%
- Brimonidine Tartrate (Alphagan-P) 0.15%
  - No generic
- Brimonidine Tartrate (Alphagan-P) 0.2%
  - No generic
Adrenergic Agonists

- Apraclonidine (Iopidine) 0.5%
  - Short term therapy
  - Acute IOP elevation
  - High incidence of ocular allergy in prolong usage
  - Tachyphylaxis

- Brimonidine Tartrate 0.2%
- Alphagan-P 0.15%/0.10%
  - More Alpha-2 selective
  - Caution with MAO inhibitors
  - BID or TID
  - Fatigue and dry mouth have been reported
  - Neuroprotection?
  - Ocular allergy

Combo Drop

- Cosopt
  - Timolol
  - Dorzolamide (Trusopt)

Combination Drop

Topical Medication Update

IRVINE, Calif., Oct 31, 2007
(BUSINESS WIRE) -- Allergan, Inc. (NYSE:AGN) today announced that the U.S. Food and Drug Administration has approved COMBIGAN(TM) Combigan
- Brimonidine tartrate 0.2% and timolol maleate 0.5%, BID

Punctal Occlusion

MIGS- Micro Invasive Glaucoma Surgery

- MIGS are prominent on glaucoma meeting agendas
  - New excitement to glaucoma treatment
  - Emerging category of procedures and devices
  - New philosophy
  - Historically glaucoma surgery was reserved for patients losing vision despite maximal medical therapy
  - MIGS hallmark is safety
  - Helps fill the gap that exists between relatively benign medical treatment/laser surgery and invasive filtration surgery
  - Overall fewer complications than trabeculectomy
  - Typically combined with cataract extraction
  - Generally “easy” to perform
**MIGS- Micro Invasive Glaucoma Surgery**

- **History**
  - Trebecome (2004)
  - Canaloplasty (iScience) 2008
  - Gonioscopy Assisted Transluminal Trabeculotomy (GATT) (2011)
  - iStent (2012)
  - First approved (device) in combination with cataract extraction
  - Other MIGS in clinical trials

- **MIGS- Micro Invasive Glaucoma Surgery**
  - Electroatlas of the trabecular meshwork
    - Trebecome (NeoMedix) (no device) 2004
  - Endoscopic Cyclophotocoagulation (ECP) (no device) 2004
  - GATT (iScience) 2008 (no device)
  - Gonioscopy Assisted Transluminal Trabeculotomy (GATT) (no device)
  - iStent trabeculotomy without a corneal incision (2012)
  - Intracanalicular Micronet
    - NeoTrab (Micronet) (no device)
    - NeoTrab (Micronet) (no device)
  - Intracanalicular Micronet
    - iStent (NeoMedix) (no device)
  - Hydrus Micronet (NeoMedix)
    - iStent (no device)
  - Gonioscopy Assisted Transluminal Trabeculotomy (GATT) (no device)
  - 360° trabeculotomy without a conjunctival incision (2011)
  - Intraocular Microstent (no device)
  - Hydrus Microstent (Ivantis)
    - Not approved in US, clinical trials
  - Hydrus Microstent (Ivantis)
    - Scaffolds the canal over much longer distance, 3 clock hours
  - Subconjunctival Shunts
    - Matches traditional approach to glaucoma surgery, to shunt aqueous into subconjunctival space.
    - InnFocus Micronet (InnFocus)
    - Xen45 (AqueSys)
    - Europe and Canada, not US (clinical trials)
  - Suprachoroidal Stents
    - Not FDA approved
    - Seeks to place through a small incision into suprachoroidal space
    - CyPass Microstent (Transcend Medical)
    - Xantus (Dexcom)
  - Video of ECP

**iStent**

**Cypass**

**Cypass Suprachoroidal Space**

**Video of ECP**
Cholinergic Agonists (miotics)

Pilocarpine

- Direct Acting Cholinergic Drops
  - Pilocarpine solution
    - 1%, 2%, 4%, 6%
  - Pilocarpine gel (Propine-HS)
    - 4%
  - Ocusert-Pilo
    - 20μg/hr & 40 μg/hr
  - Carbachol
    - 0.75%, 1.5%, 2.25% & 3.0%
    - TID

- Indirect Acting Cholinergic Drops
  - Echothiophate (Phospholine Iodide)
    - 0.125%
    - BID
  - Strong miotic used in advanced disease, patient needs to be aphakic

Ocular Side Effects
- Browache
- Globe & orbital pain
- Blurred vision
- Accommodative spasm
- Miosis
- Hyperemia
- Cataract development
- Visual field constriction

Systemic
- Sweating
- Muscle weakness
- Diarrhea

Contraindications
- Retinal tears or detachments
- Any form of ocular inflammation
- Invis
- Rubeosis
- Malignant glaucoma
- Avoid in high myopia
- Avoid in young patients

Tips
- Start with 1% and increase if necessary
  - P1, P2, P4, C3

Thank-You and Hope You Enjoyed

Greg Caldwell, OD, FAAO