Diagnosing and Managing the Glaucoma Suspect

Michael Chaglasian, O.D.
Illinois Eye Institute
Illinois College of Optometry
mchaglas@ico.edu

Outline

- Diagnosing Glaucoma
  - Risk Factors
  - Ocular Perfusion Pressure
- Optic Nerve Examination
  - The 5R's
- Gonioscopy for Everyone
  - Learn it, Love it, Live it
- Cases

Risk Assessment in Clinical Practice

CASE AC

- 51 year old
- Myopia, no sig. medical history
- Positive family history glaucoma
  - Father (85 yrs)
- GAT = 27 OD 25 OS
- CCT = ~ 565 µμ

CASE AC

VF s
Risk Calculator

http://ohts.wustl.edu/risk/calculator.html

Also iPhone App

Risk Calculator Outcomes:
Guide to Patient Management

5-Year Risk for Progression of OHTN → Glaucoma

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Range</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;5%</td>
<td>Monitor</td>
</tr>
<tr>
<td>Moderate</td>
<td>5%-15%</td>
<td>Consider treatment</td>
</tr>
<tr>
<td>High</td>
<td>&gt;15%</td>
<td>Treatment</td>
</tr>
</tbody>
</table>

The predictions derived using these methods are designed to aid, but not to replace clinical judgment.

OHTS – EGPS Limitations?

- A number of factors described as predictive in previous studies either did not add to the explanatory power of the OHTS–EGPS pooled model or were not assessed in this study. These include:
  1. Myopia, Disc Hemes
  2. Diabetes
  3. Race (?)
  4. family history of glaucoma
  5. exfoliation syndrome and pigment dispersion
Case

- Assessment
  - OHTN w/ + Fam Hx
  - Risk Calc = 8%
- Plan
  - Treat or Observe
- Future Risk?

- Is there a benefit if treatment is started now?

OHTS 2010

- Compare the two groups:
  - Those treated from beginning of study (13yrs)
  - Those observed from the beginning and then treated (5.5 yrs)

- "Is there a benefit to early treatment?"

OHTS 2010 Results

- Found little evidence that delaying prophylactic treatment by 7.5 years increased the severity of visual field loss among those who subsequently developed glaucoma;
  - minimally increased the likelihood of bilateral glaucomatous visual field loss.

- "It may be ok to delay treatment for ALL OHTN until glaucomatous change is detected"

OHTS 2010 Editorial

- "It probably still makes sense that young patients with lots of high risk factors should receive prophylaxis, while elderly patients with few risk factors should not.

- I, for one, will spend my time reminding people that there is nothing magic about an IOP of 21 mm Hg; it is merely 2 SD above the mean in some Western adult populations!"

- Alfred Sommer, MD, MHS
OHTS 2010 Summary

1. Early Tx does help some individuals, particularly those at highest risk.
2. There is little benefit of early Tx to those with low risk.
3. Tx is safe and effective for most.
4. Individuals continue to develop POAG throughout follow up.
5. Self-identified African-Americans develop POAG at a higher rate than those with same IOP.
   1. Difference is related to baseline risk factors and NOT race per se.

RF’s for Glaucoma: Diabetes

Older Data:
- No, not a Risk Factor:
  - Baltimore Eye Survey
  - Barbados Eye Study
  - European Glaucoma Prevention Study
  - Rotterdam Study
  - Visual Impairment Project

- Yes, a Risk Factor:
  - Beaver Dam Eye Study
  - Blue Mountains Eye Study
  - Nurses’ Health Study
  - Los Angeles Latino Eye Study

- Progression Risk:
  - EMGT and AGIS

- Progression NOT a Risk:
  - Barbados Eye Study

Lifestyle Factors

- Smoking
  - No definitive evidence as a RF for glaucoma

- Exercise
  - Can transiently lower IOP
  - No definitive evidence as a RF for glaucoma

- Diet
  - No supporting evidence

Sleep Apnea: Association

0% (0 of 2) - younger than 45 years,
50% (3 of 6) - 45–64 years,
63% (5 of 8) - older than 64 years

Inquire about in high risk patients.

Sleep Apnea: Risk Factor?

Conclusions: This nested case-control study does not support a large impact of sleep apnoea on the eventual development of glaucoma relative to other putative risk factors.

IOP Measurement
Tonopen: Avia

http://www.tonopen.com/avia.html

New Tonometry: iCare

http://www.edigonline.com/new_ophthalmic_equipment/tiolat.html

Clinical Sampling of IOP Is Sparse

• 525,600 minutes in a year

• ~ 2 minutes of IOP measurements assuming 4 office visits per year.

iCare One for Home Use


iCare One for Home Use

Clinical Pearls

IOP Measurement and the Cornea

“As we learn more about corneal biomechanics, we realize that there is a lot more to understanding the cornea than simple pachymetry.”

Jay Pepose, MD, PhD, Medical Director, Pepose Vision Institute

Pachymetry

Conversion Charts... don’t really work

Correction Values

<table>
<thead>
<tr>
<th>Corneal Thickness (µm)</th>
<th>Correction Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>445</td>
<td>5</td>
</tr>
<tr>
<td>465</td>
<td>4</td>
</tr>
<tr>
<td>485</td>
<td>3</td>
</tr>
<tr>
<td>505</td>
<td>2</td>
</tr>
<tr>
<td>525</td>
<td>1</td>
</tr>
<tr>
<td>545</td>
<td>0</td>
</tr>
<tr>
<td>565</td>
<td>-1</td>
</tr>
<tr>
<td>585</td>
<td>-2</td>
</tr>
<tr>
<td>605</td>
<td>-3</td>
</tr>
<tr>
<td>625</td>
<td>-4</td>
</tr>
<tr>
<td>645</td>
<td>-5</td>
</tr>
<tr>
<td>665</td>
<td>-6</td>
</tr>
<tr>
<td>685</td>
<td>-7</td>
</tr>
<tr>
<td>705</td>
<td>-8</td>
</tr>
</tbody>
</table>

Correction values according to corneal thickness of 545 µm

NOT VALID!

IOP and CCT

“Assuming that CCT can be used as a correction factor for GAT is a misinterpretation of the results of OHTS... that couldn’t be further from the truth. Adjusting IOP based on CCT is attempting to instill a degree of precision into a flawed measurement. You may actually correct in the wrong direction. The issues related to the most accurate tonometry need to include the material properties of the cornea”

James Brandt, MD, Director, Glaucoma Services, UC Davis
POAG Endpoints by Central Corneal Thickness and Baseline IOP (mmHg) in Observation Group* OHTS Data

<table>
<thead>
<tr>
<th>Baseline IOP (mmHg)</th>
<th>Central Corneal Thickness (microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;25.75</td>
<td>&lt; 555 µ High Risk</td>
</tr>
<tr>
<td>&gt;23.75 to ≤ 25.75</td>
<td>&gt;555 to &lt; 588 µ</td>
</tr>
<tr>
<td>≤ 23.75</td>
<td>&gt;588 µ Low Risk</td>
</tr>
</tbody>
</table>

* through 8 Nov 2001

Pachymetry: 3 Outcomes

- **Thin:** <555 µ  High Risk
- **Average:** 555-588 µ  No change in Risk
- **Thick:** >588 µ  Low Risk

Applied to patients with ocular hypertension

Dynamic Contour Tonometry

Ocular Response Analyzer

- The Ocular Response Analyzer utilizes a rapid air impulse, and an advanced electro-optical system to record two applanation pressure measurements; one while the cornea is moving inward, and the other as the cornea returns.

Intraocular Pressure Changes and Ocular Biometry During Sirsasana (Headstand Posture) in Yoga Practitioners


**Conclusion:** There was a uniform 2-fold increase in the IOP during Sirsasana, which was maintained during the posture in all age groups irrespective of the ocular biometry and ultrasound pachymetry. We did not demonstrate a higher prevalence of ocular hypertensives in this cohort of yoga practitioners nor did the risk factors contributing to glaucoma show any correlation with magnitude of IOP raise during the posture.

IOP is Positional

Steady State Intraocular Pressure

IOP (mm Hg) = Rate of aqueous formation + Facility of outflow

Episcleral venous pressure (mmHg)

Supine

24 Hour IOP:

- 24 Hour IOP Measured sitting and supine
  - As measured under ideal conditions in a specially designed sleep laboratory
- Found by far that the highest IOP spikes occurred while sleeping (measured supine)
  - Likely from increased episcleral venous pressure
  - Weinreb, Liu, AJO Aug 2005

IOP Is Higher At Night

Healthy habitual IOP

Glaucoma habitual IOP

IOP (mm Hg)

Clock Time

N=24

Summary

- IOP is usually highest at night.
- A single measurement of IOP during office hours is insufficient for glaucoma management.
- The diagnosis and treatment of glaucoma should include measurement of IOP at various times throughout the day and night, if possible.
- The optimal way to estimate the 24-hour IOP peak to enhance diagnosis and treatment of glaucoma is not known.
- It is important to consider the effectiveness of anti-glaucoma medications for lowering 24-hour IOP.

Timolol and Nocturnal IOP Control

Timolol gel

Brimonidine Efficacy During Nocturnal Period

**Brinzolamide vs. Timolol: Adjunct to Latanoprost in an Open-Label Study**

![Graph showing IOP changes over time with Brinzolamide and Timolol as adjuncts to Latanoprost](image)


**Travoprost Reduces and Sustains Habitual IOP-lowering**

![Graph showing IOP changes with Travoprost compared to baseline](image)


**IOP Lowering Medications Have Differing Diurnal and Nocturnal Efficacy**

![Graph showing IOP changes with Timolol, Dorzolamide, and Latanoprost](image)


**Our Understanding of Glaucoma and Progression IOP Has Been Expanded By Recent Studies**

![Cartoon image of two cats discussing IOP](image)

**Ocular Perfusion Pressure**

- The differential between arterial BP and IOP
  - Ocular perfusion is regulated to maintain constant blood flow to the optic nerve despite fluctuating blood pressure and IOP
  - The major cause of reduced blood flow is thought to be secondary to vascular dysregulation in susceptible patients, resulting from abnormal/insufficient autoregulation.

**Ocular Perfusion Pressure**

- risk factor for glaucoma
- New Evidence

**Ocular Perfusion Pressure (OPP) = BP - IOP**

(BP is mean arterial pressure, diastolic BP, or systolic BP)
OPP and Glaucoma: Hemodynamics

- SPP = SBP – IOP
- DPP = DBP – IOP (Diastolic)
- easiest to use, best current evidence
- MPP = 2/3 mean arterial pressure – IOP
- Arterial Pressure = DBP + 1/3 (SBP – DBP)
- May best reflect perfusion physiology

Lower Diastolic, Systolic, or Mean Pressure Reduces Perfusion Pressure

Higher IOP Negatively Impacts Perfusion Pressure

Perfusion Pressure Is a Result of A Delicate Balance Between IOP and Blood Pressure

Ocular Perfusion Pressure and Glaucoma Progression

Ocular Perfusion Pressure (OPP) = BP – IOP
(BP is mean arterial pressure, diastolic BP, or systolic BP)

Low ocular perfusion pressure has been shown to be strongly associated with the prevalence of glaucoma progression in multiple population-based surveys

- Leske et al Ophthalmology 114 (11), November 2007

POAG Risk Factors 9-year BES

- Age
- Glaucoma Family History
- IOP monthly
- Like Intraocular Pressure
- SBP monthly
- Thin plate CCT (mm)

Ocular Perfusion Pressure and Glaucoma Progression: Population Studies

- Baltimore Eye Survey (AA and Caucasian)²
  - 6x excess of POAG in subjects with lowest category of Ocular Perfusion Pressure (OPP)
- Egna-Numarkt Study (Caucasian)²
  - Lower Diastolic Ocular Perfusion Pressure (DOPP)
  - associated with marked, progressive increase in frequency of POAG
- Barbados 4 yr Eye Study (African-Caribbean)³
  - 4-year risk of developing glaucoma increased dramatically at lower perfusion pressure
- Proyecto Ver (Hispanic)⁴
  - Found lower Diastolic Perfusion Pressure (DPP) associated with increased risk of POAG

POAG Risk Factors 9-year BES

- Cross-sectional study of 6,357 Latinos, >40 years in Los Angeles, CA.
- Persons with low diastolic and systolic perfusion pressures had a higher risk of POAG.
- DOPP <50 mmHg, the prevalence of glaucoma rapidly increases linearly.

Los Angeles Latino Eye Study

Clinical Control of OPP

- Lower IOP improves OPP
- Remains number 1 goal!!
- Measure blood pressure on your patients

- Higher systemic BP improves OPP, but you do not necessarily want to raise BP:
  - Stroke #3 cause of death in US behind CVD & CA!
  - Avoid drugs that lower systemic BP beyond patient’s desired systemic control.
  - Avoid nocturnal hypotension.
  - Communicate with PCP

Nocturnal Hypotension and OPP

- Low blood pressure (BP) at night, coupled with high IOP in supine position, compromise OPP.
  - Up to 50% of patients with HTN
  - Using systemic BP meds in the AM to minimize nocturnal hypotension makes sense.

- Using IOP lowering drugs that lower IOP while sleeping makes sense.
  - Avoiding IOP meds that LOWER systemic BP at night (beta blockers, alpha agonists) makes sense.

24 Hour Blood Pressure

- Holter Monitor

24 hr IOP Measure via SCL

SENSIMED Triggerfish® - Continuous IOP Monitoring

- Not approved in USA
Glaucam Medications and Their Effects on OPP

- 27 Patients treated with
  - Newly Diagnosed
  - No CVD / HTN
  - No systemic beta-blockers
- BID Timolol 0.5%/Dorzolamide 2% or
- QHS Latanoprost 0.005%
  - for six weeks, followed by a 4-week washout period between treatments.
- 24-hour IOP monitoring in habitual position.
- 24-hour systemic blood pressure monitoring.


Mean 24-Hour Diastolic OPP Results

- Reduction in DOPP is a risk factor for glaucoma progression

Case WS

- 75 yo male
- + HTN w/ multiple BP meds x 20+ yrs
  - 105/68 in office
  - 5’5”, 142 lbs
- CCT= 532µ
- Initial IOP 23 mmHg
  - Now repeatedly 11-13 mmHg over 5+ years
- Current Medication:
  - PGA
- Good compliance and follow up
Can you see the change?

Case

- Q= What is the Explanation?
- Compliance?
Other *Potential* Risk Factors: ESTIMATED
- 24 Hour IOP
  - IOP of 12 mmHg @ 2PM = ?? @ 2AM ~ 18 mmHg
- DOPP
  - DBP of 68 mmHg @ 2PM = ?? @ 2AM ~ 58 mmHg
- ? DOPP @ 2AM = 58 -18 = 40 mmHg?
**Case**

- Is there anything else that can be done?
- Possibly:
  - Offer Nocturnal IOP control
  - Offer Improved DOPP
  - Add CAI to PGA BID

**Letter to PCP:** explain OPP and Low BP related Risk, ? Adjust meds

**Summary: OPP and Glaucoma Progression**

- Low ocular perfusion pressure (OPP) is an important risk factor for glaucoma
- OPP is amenable to modification by lowering IOP and improving perfusion pressure
- New strategies are needed to take advantage of this modifiable risk factor


**Glaucoma Diagnosis**

- How well can we identify early glaucoma?
  - Optic Disc Damage
  - Nerve Fiber Layer Loss
  - Functional Loss
    - Standard Automated Perimetry (SAP)
    - SWAP, FDP
- Still some debate, Which comes first?
  - Where to put your money?

**Clinical Pearls**

**Optic Nerve Evaluation**

“*The 5Rs*”

- Ring, Rim, RNFL, Region, Retinal disc heme

Adapted from FORGE program
R. Weinreb, F. Medeiros, R. Susanna

**Begin with a system**

Five rules to evaluate the optic disc and retinal nerve fiber layer for glaucoma

**Rule #1: Scleral Ring**

- Identify the size and limits of the optic disc
- Vertical and Horizontal measurement
- Direct Ophthalmoscope
  - Small (5 degree aperture) = avg. disc
- Volk 60 lens
  - Volk 90 x 1.3 correction factor
- Disc size relates to cup size

**Clinical Pearls**

Optic Nerve Evaluation

“The 5Rs”

Adapted from FORGE program
R. Weinreb, F. Medeiros, R. Susanna

**Summary: OPP and Glaucoma Progression**

- Low ocular perfusion pressure (OPP) is an important risk factor for glaucoma
- OPP is amenable to modification by lowering IOP and improving perfusion pressure
- New strategies are needed to take advantage of this modifiable risk factor

**Scleral Ring and Disc Size**

- **Scleral Ring**
  - Outer Disc Margin

- **First Step in Determining Disc Size**

**Scleral Ring and Disc Size**

- At the Slit Lamp
  - Volkm Lenses:
    - 60D = x 1.0
    - 78D = x 1.1
    - 90D = x 1.3

**Scleral Ring and Disc Size**

- **Rule #2: Size of Neuroretinal Rim**
  - **Rim Width**
    - Distance between outside border of disc and bending of blood vessel on inner rim
  - **ISN’T Rule:**
    - Inferior > Superior > Nasal > Temporal
    - Does not always "work"
  - **Localized Notching / Thinning**
  - **Color of Rim**

**Neuroretinal Rim**

- **Rim Width**
  - Distance between border of disc and position of blood vessel bending

**Localized Rim Thinning/Notching**

- Notch
Width of the NRR around the disc.

**Rule #3: Examine the RNFL**
- Best seen in younger glaucoma patients with clear media and dark fundus pigmentation
- Try red-free light, 78D (or new Digital 1.0) lens for best FOV/mag
- Look for:
  - Striations, Brightness,
  - Localized and Diffuse RNFL loss

**Diffuse RNFL Loss**
- Normal RNFL
- Diffuse RNFL loss (advanced glaucoma)

**Localized RNFL Loss**
- Localized RNFL defect
- Wedge-shaped dark area

**Advanced Digital Imaging (SLO’s)**
- Recommended as a clinical tool to augment and facilitate the assessment of the optic disc and RNFL in the management of glaucoma.
- Assist with progression analysis
  - HRT
  - Optical Coherence Tomography (OCT)
  - GDx
Rule #4: Region of Peripapillary Atrophy

- Alpha Zone (outer)
  - Hypo and hyperpigmented areas
  - Present in normal and glaucoma eyes
- Beta Zone (inner)
  - Area of RPE atrophy
  - See large choroidal vessels
  - Larger beta zone=thinner NRR
  - More common in glaucoma eyes

Region of PPA

- Alpha Zone
  - Hypo and Hyperpigmented areas
  - Seen in normal and in glaucoma
- Beta Zone (inner)
  - RPE atrophy @ disc margin
  - See choroidal vessels
  - More common in glaucoma
Rule #5: Retinal and Disc Hemorrhages

- Strongly indicative of glaucoma progression
  - Likely need to increase treatment
- Normally disappear after 2-6 months
- Can be very subtle, look closely, look every visit (undilated)

Optic Disc Hemorrhage

Indicative of glaucoma progression

Optic Disc Hemorrhage

Normally disappears after 2-6 months

Patients with Narrow Angles

Narrow Angles

- Mandatory Practice Guideline:
  - Always gonioscopy for van Herrick Grade 2 angles or less.
  - Be cautious with older, hyperopic patients
  - Thoroughly discuss risks/benefits with patient

- AOA Clinical Practice Guideline 2002

Gonioscopy Lenses

- Volk G-4 nf
- Volk G-4
  - 2 in 1
  - www.volk.com
Gonioscopy Lenses

- Posner 4 mirror
  - Handle
- Sussman 4 mirror
  - No handle
  - www.ocular-instruments.com

GONIOSCOPY

- Look for areas of peripheral anterior synechia (PAS) as evidence of past closure attacks
  - Grade percent of angle covered
- Gonioscopy of both eyes to confirm a narrow angle approach (symmetry).

Techniques and tips

Indentation Gonioscopy

A. = Appositional angle closure
B. = Synechial angle closure
Occludable Angles:

- Less than 15° degree approach to the angle for 360°, often less than 10°
  - With PAS
- Less than 1/2 of TM is visible gonioscopically
  - (obscured by peripheral iris)
- When any significant portion of the angle is gonioscopically open to full TM, acute angle closure is difficult to achieve.

LPI Referral

- For patients who meet the gonioscopic criteria an LPI is a much less risky option than waiting for acute angle closure to develop.
- A second opinion is often warranted as the determination for an LPI is primarily a clinical decision based on gonioscopy.

CASES

Case

- 34 yo, white, male
- Ant Segment:
  - K-Spindle, + ITD, 3+ TM pigment
- GAT= 28/31 mmHg OD/OS
- Pachymetry = 595 µ
Dx and Mx the Glaucoma Suspect

Case

- Assessment
  - PDS, High IOP, thick Pach
  - Normal ONH, Normal VF, Normal OCTs
- Plan
  - Other Tests?
  - Treatment Trial: PGA
  - Target Pressure:
  - Other considerations: ½% Pilocarpine, LPI
- Risk ??

Case JB

- 54 yo WF
- Referred in for Glaucoma Suspect
- No significant Medical History
- GAT = 24 OD and 23 OS
- Pachs = 560 and 565
- Gonio=
  - Open angle with moderate pigment

Photos

Visual Field
Slit Lamp

Summary / Questions
- Does this patient have glaucoma?
- If not, how high is the risk for developing glaucoma?
- What other tests need to be done?
- When do you see this patient back?
- When/How do you start treatment?
- What is the prognosis for this patient?