Diagnosing and Managing the Glaucoma Suspect

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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 µ

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.

M. Chaglasian, OD
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

- Found little evidence that delaying prophylactic treatment by 7 1/2 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.
   - 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.

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


Reichert 7CR Auto Tonometer + Corneal Response Technology

- Normal Tension Glaucoma patients
- Primary Open Angle Glaucoma patients
- Post-LASIK and refractive surgery patients
- Patients with Fuchsí or Corneal Edema
- Keratoconus patients
- Patients with thick, thin, or otherwise biomechanically atypical corneas

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

Correction Values

<table>
<thead>
<tr>
<th>Corneal Thickness (µm)</th>
<th>Correction Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>405</td>
<td>7</td>
</tr>
<tr>
<td>425</td>
<td>5</td>
</tr>
<tr>
<td>445</td>
<td>4</td>
</tr>
<tr>
<td>465</td>
<td>3</td>
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<tr>
<td>485</td>
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<td>585</td>
<td>-3</td>
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<td>625</td>
<td>-5</td>
</tr>
<tr>
<td>645</td>
<td>-6</td>
</tr>
<tr>
<td>665</td>
<td>-7</td>
</tr>
<tr>
<td>685</td>
<td>-8</td>
</tr>
</tbody>
</table>

Correction values according to corneal thickness of 545 µm

Conversion Charts: don’t really work

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

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

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

*Ophthalmology* 2006; 113:1327-1332.

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 biomey 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

\[
\text{IOP (mm Hg)} = \text{Rate of aqueous formation} + \frac{\text{Facility of outflow}}{\text{Epicleral venous pressure (mmHg)}}
\]

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

<table>
<thead>
<tr>
<th>Clock Time</th>
<th>Healthy Habitual IOP</th>
<th>Glaucoma Habitual IOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30 AM</td>
<td>3.30 PM</td>
<td>5.30 PM</td>
</tr>
<tr>
<td>7:30 PM</td>
<td>9:30 PM</td>
<td>11:30 PM</td>
</tr>
<tr>
<td>1:30 AM</td>
<td>3:30 AM</td>
<td>5:30 AM</td>
</tr>
<tr>
<td>9:30 AM</td>
<td>11:30 AM</td>
<td>1:30 PM</td>
</tr>
</tbody>
</table>

IOP (mm Hg)

N=24

Nocturnal, Supine

Diurnal, Sitting

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

- No treatment
  - Timolol gel

Brimonidine Efficacy During Nocturnal Period

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

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

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
Ocular Perfusion Pressure and Glaucoma Progression

**OPP and Glaucoma Progression: Population Studies**

- **Baltimore Eye Survey (AA and Caucasian)**
  - 6x excess of POAG in subjects with lowest category of Ocular Perfusion Pressure (OPP)

- **Egna-Numarkt Study (Caucasian)**
  - Lower Diastolic Ocular Perfusion Pressure (DOPP) associated with marked, progressive increase in frequency of POAG

- **Barbados 4 yr Eye Study (African-Caribbean)**
  - 4-year risk of developing glaucoma increased dramatically at lower perfusion pressure

- **Proyecto Ver (Hispanic)**
  - Found lower Diastolic Perfusion Pressure (DPP) associated with increased risk of POAG

**POAG Risk Factors 9-year BES**

**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:
  - 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

Mechanism of Glaucoma has gotten complicated:

Glaucoma 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.


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Mean 24-Hour Diastolic OPP Results

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

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

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

Scleral Ring and Disc Size

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

Scleral Ring and Disc Size

- Scleral Ring = Outer Disc Margin
- First Step in Determining Disc Size

Scleral Ring and Disc Size

- Small
- Average
- Large

Disc/Cup Size ≠ Risk
**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

**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

**Color of Rim vs. Pallor**

- Pallor > cup
- Non-glaucomatous neuropathy

**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

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

Flame-shaped hemorrhage

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 synechiae (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 150° 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.