Primary Open Angle Glaucoma

Definition

- A chronic, bilateral, often asymmetrical disease in adults, featuring acquired loss of optic nerve fibers and abnormality of visual field with an open anterior chamber angle.

Definition A.A.Ophthalmology

- POAG is a multifactorial optic neuropathy in which there is a characteristic acquired loss of retinal ganglion cells and atrophy of the optic nerve.
Issue related to primary or secondary

- Classification important for clinical management.
- The division into primary and secondary is arbitrary because...

- A term idiopathic open angle glaucoma is possibly better suited instead of POAG

POAG

- Chronic
- Bilateral
- Often asymmetric
- Adults
- Acquired optic nerve fiber loss.
- Acquired visual field loss.
POAG -2

- Open chamber angle with normal appearance
- IOP often over 21 mmHg

Pathophysiology

- Needs to be established.
- A process causes death of retinal ganglion cells by apoptosis

Factors contributing pathophysiology in glaucoma
Goals

- Document status of optic nerve structure and function
- Target pressure - so damage is unlikely to happen
- Maintain IOP below target pressure

Goals cont...

- Monitor status of the optic nerve and reset target pressure if deterioration occurs.
- Minimize side effects of management and impact on vision and general health and quality of life.
- Educate and engage the patient in management

Risk factors of POAG

- IOP
- Age
- Race
- Family history
- Optic nerve
- Central corneal thickness
- Vascular disease
- Myopia
Intraocular pressure

- Sustained elevated IOP causes optic nerve damage in POAG
- Furthermore decrease in IOP lessens the risk of visual field progression

IOP related statistics

- Inter-individual variation in susceptibility of optic nerve to IOP-related glaucoma damage
- Only 1/10th of patients with elevated IOP have VF loss (Sommer 1991)
- 10% of OHT develop glaucoma in 5 years
IOP related statistics -2

- How many OHT develop to glaucoma in 10 years?
- 15-40% of OHT develop into glaucoma
- 1/6 patients with disc and field damage have IOP less than 21 mmHg

- However IOP is fundamental to the current design of therapy for POAG.
- Elevated IOP is treatable cause and hence…one can expect to retard progression in many by lowering IOP

- More the IOP is reduced, the more likely it is that progression of glaucomatous optic nerve damage will be retarded.
Race- Risk factor

- Prevalence is 4-5 times in African Americans when compare to the others
- IOP in Caucasians is similar to African Americans
- Blindness is 8—times more common in African Americans than in Caucasians

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### Caucasian Americans

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No. Screened</th>
<th>No. of Cases</th>
<th>Observed Rate/100 (95% CI)*</th>
<th>Adjusted Rate/100 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-49</td>
<td>543</td>
<td>1</td>
<td>0.18 (0.02,1.03)</td>
<td>0.92 (0.2,2.72)</td>
</tr>
<tr>
<td>50-59</td>
<td>618</td>
<td>2</td>
<td>0.32 (0.03,1.17)</td>
<td>0.41 (0.03,0.98)</td>
</tr>
<tr>
<td>60-69</td>
<td>915</td>
<td>7</td>
<td>0.77 (0.31,1.57)</td>
<td>0.88 (0.14,1.62)</td>
</tr>
<tr>
<td>70-79</td>
<td>631</td>
<td>18</td>
<td>2.85 (1.70,4.50)</td>
<td>2.89 (1.44,4.34)</td>
</tr>
<tr>
<td>80+</td>
<td>206</td>
<td>4</td>
<td>1.94 (0.49,4.95)</td>
<td>2.16 (0.05,4.20)</td>
</tr>
<tr>
<td>Total</td>
<td>2,913</td>
<td>32</td>
<td>1.10 (0.75,1.55)</td>
<td>1.29 (0.80,1.78)</td>
</tr>
</tbody>
</table>

### African Americans

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No. Screened</th>
<th>No. of Cases</th>
<th>Observed Rate/100 (95% CI)*</th>
<th>Adjusted Rate/100 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-49</td>
<td>632</td>
<td>6</td>
<td>0.05 (0.05,2.07)</td>
<td>1.23 (0.23,2.24)</td>
</tr>
<tr>
<td>50-59</td>
<td>699</td>
<td>25</td>
<td>3.58 (2.32,5.26)</td>
<td>4.65 (2.47,5.63)</td>
</tr>
<tr>
<td>60-69</td>
<td>614</td>
<td>31</td>
<td>5.05 (3.42,7.17)</td>
<td>5.51 (3.57,7.46)</td>
</tr>
<tr>
<td>70-79</td>
<td>349</td>
<td>27</td>
<td>7.74 (4.94,10.54)</td>
<td>9.15 (5.83,12.48)</td>
</tr>
<tr>
<td>80+</td>
<td>101</td>
<td>11</td>
<td>10.89 (4.81,16.97)</td>
<td>11.26 (4.52,18.00)</td>
</tr>
<tr>
<td>Total</td>
<td>2,395</td>
<td>100</td>
<td>4.18 (3.38,4.98)</td>
<td>4.74 (3.81,5.67)</td>
</tr>
</tbody>
</table>
Other risk factors

- Age
- Family history
- Low diastolic perfusion pressure
- DM no detectable association

Early detection

Screening methods - IOP

- IOP poor screening tool
  - Sensitivity 47.1% specificity 92.4%
  - Most people with high pressures do not have or never develops POAG
Screening methods
- Screening can be made more effective by including ONH and RNFL assessment.
- Standard visual field is time consuming.
- Frequency doubling technology shows promise as a screening tool.

Screening cont...
- Screening can be more efficient if:
  - Targeted to specific groups
  - Older population
  - African Americans
  - Relatives of glaucoma patients

Glaucoma exam
- History
- Pupil exam – reactivity, APD
- Slit-lamp
- IOP with GAT or GAT type equipment
- Central Corneal Thickness – ultrasonic or advanced non-contact methods
Glaucoma exam-cont

- Gonioscopy
- Optic nerve and RNFL
- Documentation of ONH and RNFL
- Evaluation of fundus
- Visual field

Target pressure

- A theoretical value below which visual field and ONH appear stable (not deteriorating).
- Calculated from highest recorded untreated IOP.
- Conventionally 20-30% decrease in IOP.
- 40% or more if severe glaucoma

Target pressure calculation

- Target Pressure = Maximum IOP - Max IOP% - Z

Max IOP % can be approximately 20 or 30% of max IOP value.

<table>
<thead>
<tr>
<th>Z</th>
<th>Optic Nerve Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal disc &amp; Normal Visual Field</td>
</tr>
<tr>
<td>1</td>
<td>Abnormal Disc &amp; Normal Visual Field</td>
</tr>
<tr>
<td>2</td>
<td>Visual Field Loss not threatening fixation</td>
</tr>
<tr>
<td>3</td>
<td>Visual Field Loss threatening or involving fixation</td>
</tr>
</tbody>
</table>

Table 1. Grading scale to define the optic nerve damage severity factor Z.

Jampel H 1997 Journal of Glaucoma
Example of Target IOP calc

- Max IOP 30 mmHg
- Z score 1

Target IOP = ?

Recommended time to follow-up

<table>
<thead>
<tr>
<th>Target IOP Achieved</th>
<th>Progression of Damage</th>
<th>Duration of Control (months)</th>
<th>Follow-up Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>no</td>
<td>&lt;6</td>
<td>1-6 months</td>
</tr>
<tr>
<td>yes</td>
<td>no</td>
<td>&gt;6</td>
<td>3-12 months</td>
</tr>
<tr>
<td>yes</td>
<td>yes</td>
<td>(&lt;6)</td>
<td>1 week - 3 months</td>
</tr>
<tr>
<td>no</td>
<td>no</td>
<td>(&lt;6)</td>
<td>1 day - 5 months</td>
</tr>
<tr>
<td>no</td>
<td>yes</td>
<td>(&lt;6)</td>
<td>1 day - 1 month</td>
</tr>
</tbody>
</table>

Recommended time to visual fields

<table>
<thead>
<tr>
<th>Target IOP Achieved</th>
<th>Progression of Damage</th>
<th>Duration of Control (months)</th>
<th>Follow-up Interval (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>no</td>
<td>&lt;6</td>
<td>5-18</td>
</tr>
<tr>
<td>yes</td>
<td>no</td>
<td>&gt;6</td>
<td>5-24</td>
</tr>
<tr>
<td>yes</td>
<td>yes</td>
<td>(&lt;6)</td>
<td>2-6</td>
</tr>
<tr>
<td>no</td>
<td>no</td>
<td>(&lt;6)</td>
<td>2-6</td>
</tr>
<tr>
<td>no</td>
<td>yes</td>
<td>(&lt;6)</td>
<td>1-6</td>
</tr>
</tbody>
</table>
Recommended time to ONH evaluation

<table>
<thead>
<tr>
<th>Target IOP Achieved</th>
<th>Progression of Damage</th>
<th>Duration of Control (months)</th>
<th>Follow-up Interval (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>no</td>
<td>&lt;6</td>
<td>6-12</td>
</tr>
<tr>
<td>yes</td>
<td>no</td>
<td>&gt;6</td>
<td>6-18</td>
</tr>
<tr>
<td>yes</td>
<td>yes</td>
<td>(n/a)</td>
<td>3-12</td>
</tr>
<tr>
<td>no</td>
<td>no</td>
<td>(n/a)</td>
<td>3-12</td>
</tr>
<tr>
<td>no</td>
<td>yes</td>
<td>(n/a)</td>
<td>3-12</td>
</tr>
</tbody>
</table>

Optic disc appearance and visual field loss

- ONH appearance and visual fields have assumed predominant roles
- Careful evaluation of ONH and VF is a must
- Stereophotography “gold standard”

ONH and VF cont...

- Computerized imaging of ONH may enhance your ability to detect subtle changes
ONH and VF clinical signs
- Asymmetry of neuroretinal rim
- Focal thinning or notching of neuroretinal rim
- Optic disc hemorrhage (strong correlation)
- Acquired change in disc rim or RNFL appearance
- Visual field changes must correlate with disc changes.
- If it does not correlate or does not correlate well... warrants further investigation.

Prognosis
- Most POAG patients will retain useful vision for their entire life
- Incidence of blindness 27% vs 9% (unilateral versus bilateral) at 20 years following diagnosis.
- Prevalence of bilateral blindness 8% vs 4% (black versus white population)
Prognosis

Lowering IOP has shown a significantly reduce progression and possibly halt it.

Glaucmatous Disc Classifications

1 Focal
2 Myopic
3 Senile sclerotic
4 Concentric
5 Advanced

Systematic evaluation of nerve
1. Observe the scleral ring to identify the limits of the optic disc and evaluate its size.

Measure Disc Size

- Observe the scleral ring to identify the limits of the optic disc and evaluate its size.
  - 66D 1 X magnification

- Cup size is associated with disc size

- Effects any casual observer for cup to disc ratio measurement

- Rim thickness varies with disc size

Disc size

- Small < 1.5 mm
- Medium > 1.5 but < 2.5 mm
- Large > 2.5 mm
Neuroretinal rim characteristics

- Color of rim: pale rims not good
- Width of rim in all sectors
- ISNT rule
- ISNT rule is accurate about 70% of times

RNFL

- Healthy eye has striations
- A certain amount of NFL is required for visibility
- RNFL loss can be diffuse, localized or mixed

RNFL cont...

- Diffuse – reduction in RNFL brightness
- Localized – wedge shaped defect
- Localized RNFL defects should traced back the disc
Peripapillary atrophy

- Where
- How large

- 1/8, ¼, ½, ¾, 1, > 1 DD

Retinal and optic disc hemorrhages

- Transient
- Inferior temporal or superior temporal regions mainly

- Record present or absent
- If present where
Retinal vessels

Look for this in patients that you suspect NTG

CD ratio

- Vertical
- Horizontal
- Largest

CD ratio of imaging devices will not match your findings!

Factors influencing interpretation
Large physiologic cups

Asymmetry
ONH in Myopia

- Vertical – oval shape
- Thinning of temporal neural rim
- Prominent peripapillary halo

Any signs of glaucoma?

Tilted disc syndrome

- Horizontally oval disc
**Signs to look for**

- Focal atrophy of rim
- Barring of circumlunar vessel
- Nasal cupping
- Laminar dots sign

**Signs to look for**

- Bayonetting sign
- Nerve fiber layer defects
- Disc hemorrhage

**Focal atrophy of neural rim**
Focal atrophy of neural rim-2

Optic disc hemorrhages

Optic disc hemorrhages-2
Optic disc hemorrhages-3

3 years later

Barring of circumlinear vessels
- Vessels that runs along margin between cup and neural rim.
- Found supero and infero temporally

Barring of circumlinear vessels
- As rim becomes thinner it leaves an area of pallor between the rim and the circumlinear blood vessel.
Barring of circumlinear vessels

Laminar dot sign

Bayonetting

- Double angulation of blood vessel.
Nerve fiber bundle defect

- Rim changes also produces RNFL defects.
- Dark stripes or wedge shapes defect paralleling the normal striations.
- Common after disc hemorrhages

Other vascular signs

- Proximal constriction of retinal arteries
Other vascular signs

- Shunt vessels
- Advanced glaucomatous change because of the obstruction of venous flow through distorted lamina cribrosa.
Gonioscopy

A = Above Schwalbe line, totally occluded angle.
B = Behind the Schwalbe line, peripheral iris is in contact with TM.
C = Scleral spur Iris root at the level of scleral spur
D = Deep anterior ciliary body seen.
E = extremely deep
Van Herrick angle estimation

- 1:1 – Open angle, VH grade 4
- 1:1/2 – Open angle, VH grade 3
- 1:1/4 – Narrow angle, VH grade 2 (Angle Closure Possible)
- 1: <1/4 – Angle closure likely, VH grade 1

Current practice patterns

- Unacceptable high pressures will inevitably destroy optic nerve tissue
- Safe levels of IOP by any means warranted
  - If these don't work or not sufficient
    - drugs like – prostaglandins
    - reduction in inflow – beta blockers
- Maximal medical therapy
- Consider surgery

Maximal tolerated medical therapy
Do we really have the luxury to use them all?

- Stage of disease
  - Visual field status
- Stage of nerve damage
  - Rim tissue remaining
- Type of glaucoma
  - POAG – medical first makes sense
  - Secondary glaucoma
  - Congenital glaucoma – treated differently
  - Complete angle closure
- Adherence, compliance, persistence issues
- Effect of medications and future outcomes of surgery
Target pressure

- A theoretical value below which visual field and ONH appear stable (not deteriorating).
- Calculated from highest recorded IOP.
- Conventionally 20-30% decrease in IOP.
- 40% or more if severe glaucoma

Medications

- First line drugs: prostaglandin analogs
- Second line: Beta blockers, Alpha 2 agonist, Carbonic anhydrase inhibitor
- Third: Combination with prostaglandin
  - Eg: PGA (Travatan z) and CAI+ Beta blocker (COSOPT)
    - PGA + brinzolamide/brimonidine (Simbrinza)

Where should the IOP be?

- No real number
- Start with 30% drop
- Monitor for progression
  - Advanced glaucoma you want IOP to be less than 12
  - Pressure should not fluctuate much