

Primary Open Angle Glaucoma

Pinakin G Davey OD, PhD, FAAO
Professor and Director of Research



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.

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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.

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Issue related to primary or secondary

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

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

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POAG

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

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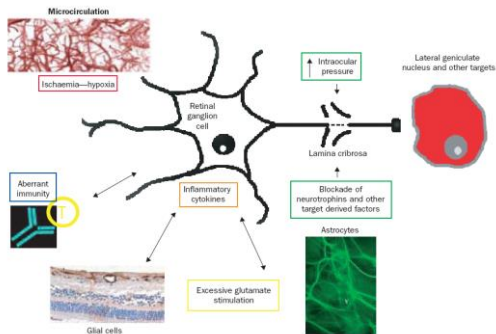
POAG -2

- ▶ 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

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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

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Risk factors of POAG

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

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Intraocular pressure

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

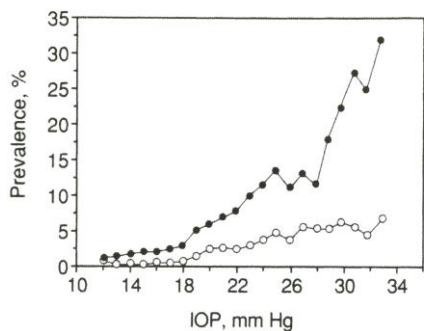


Figure 1. Prevalence of primary open-angle glaucoma in relation to screening IOP.
 Note: The curve is smoothed using a running mean with window width of 7 mm Hg.
 Caucasian American subjects, n = 5,700 eyes (open circles); African American subjects, n = 4,674 eyes (closed circles).

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

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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

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

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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

Caucasian Americans

Age (years)	No. Screened	No. of Cases	Observed Rate/100 (95% CI)*	Adjusted Rate/100 (95% CI)
40-49	543	1	0.18 (0.02-1.03)	0.92 (0-2.72)
50-59	618	2	0.32 (0.03-1.17)	0.41 (0-0.98)
60-69	915	7	0.77 (0.31-1.57)	0.88 (0.14-1.62)
70-79	631	18	2.85 (1.70-4.50)	2.89 (1.44-4.34)
≥80	206	4	1.94 (0.49-4.95)	2.16 (0.05-4.26)
Total	2,913	32	1.10 (0.75-1.55)	1.29 (0.80-1.78)

African Americans

Age (years)	No. Screened	No. of Cases	Observed Rate/100 (95% CI)*	Adjusted Rate/100 (95% CI)
40-49	632	6	0.95 (0.35-2.07)	1.23 (0.23-2.24)
50-59	699	25	3.58 (2.32-5.26)	4.05 (2.47-5.63)
60-69	614	31	5.05 (3.42-7.17)	5.51 (3.57-7.46)
70-79	349	27	7.74 (4.94-10.54)	9.15 (5.83-12.48)
≥80	101	11	10.89 (4.81-16.97)	11.26 (4.52-18.00)
Total	2,395	100	4.18 (3.38-4.98)	4.74 (3.81-5.67)

Other risk factors

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

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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

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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

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Screening cont...

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

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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

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Glaucoma exam-cont

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

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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**

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Target pressure calculation

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

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

Z	Optic Nerve Damage
0	Normal disc & Normal Visual Field
1	Abnormal Disc & Normal Visual Field
2	Visual Field Loss not threatening fixation
3	Visual Field Loss threatening or involving fixation

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

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Jampel H 1997 Journal of Glaucoma

Example of Target IOP calc

- ▶ Max IOP 30 mmHg
- ▶ Z score 1

- ▶ Target IOP = ?

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Recommended time to follow-up

Target IOP Achieved	Progression of Damage	Duration of Control (months)	Follow-up Interval
yes	no	<6	1-6 months
yes	no	>6	3-12 months
yes	yes	(n/a)	1 week - 3 months
no	no	(n/a)	1 day - 3 months
no	yes	(n/a)	1 day - 1 month

▶

Recommended time to visual fields

Target IOP Achieved	Progression of Damage	Duration of Control (months)	Follow-up Interval (months)
yes	no	<6	6-18
yes	no	>6	6-24
yes	yes	(n/a)	2-6
no	no	(n/a)	2-6
no	yes	(n/a)	1-6

▶

Recommended time to ONH evaluation

Target IOP Achieved	Progression of Damage	Duration of Control (months)	Follow-up Interval (months)
yes	no	<6	6-12
yes	no	>6	6-18
yes	yes	(n/a)	3-12
no	no	(n/a)	3-12
no	yes	(n/a)	3-12



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"



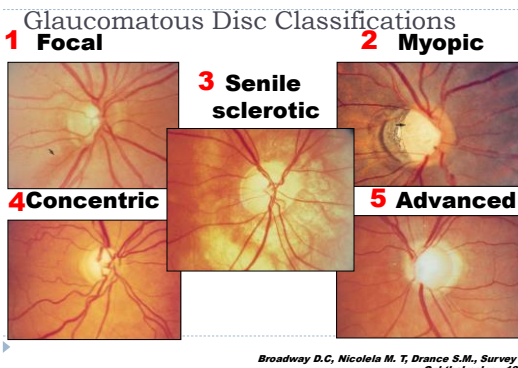
ONH and VF cont...

- ▶ Computerized imaging of ONH may enhance your ability to detect subtle changes



Prognosis -2

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



Systematic evaluation of nerve

-
- ▶ I. Observe the scleral ring to identify the limits of the optic disc and evaluate its size.

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Measure Disc Size

- ▶ Observe the scleral ring to identify the limits of the optic disc and evaluate its size.
 - ▶ 66D I 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

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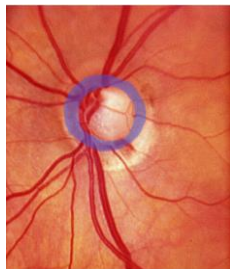
Disc size

- ▶ Small < 1.5 mm²
- ▶ Medium > 1.5 but <2.5 mm²
- ▶ Large > 2.5 mm²

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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

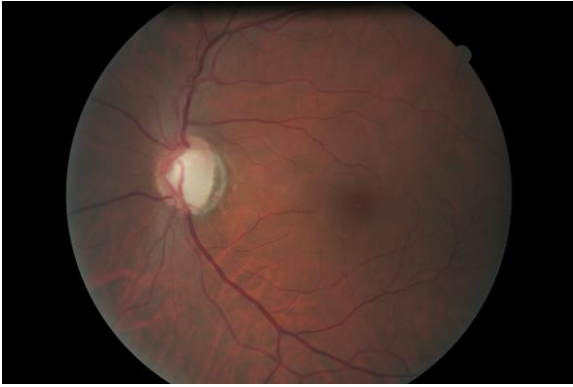
- ▶ Healthy eye has striations
- ▶ A certain amount of NFL is required for visibility
- ▶ RNFL loss can be diffuse, localized or mixed



RNFL cont...

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



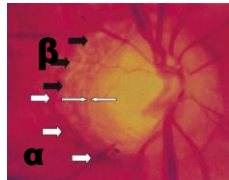


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Peripapillary atrophy

- ▶ Where
- ▶ How large

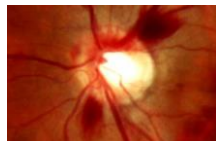
▶ $1/8, 1/4, 1/2, 3/4, 1, > 1$ DD



▶

retinal and optic disc hemorrhages

- ▶ Transient
- ▶ Inferior temporal or superior temporal regions mainly
- ▶ Record present or absent
- ▶ If present where



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Retinal vessels



Look for this in patients that you suspect NTG



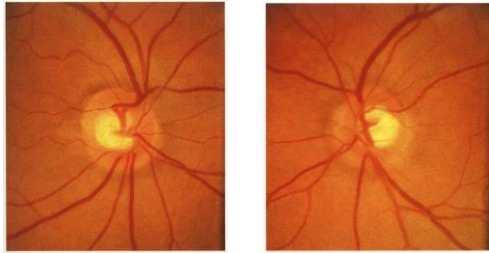
CD ratio

- ▶ Vertical
- ▶ Horizontal
- ▶ Largest
- ▶ CD ratio of imaging devices will not match your findings!

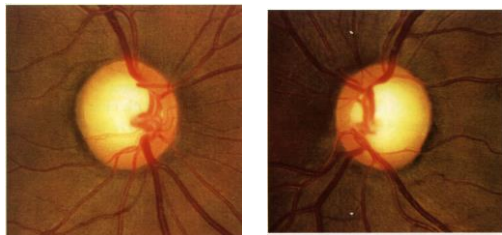


Factors influencing interpretation

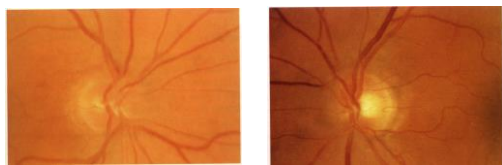
Large physiologic cups



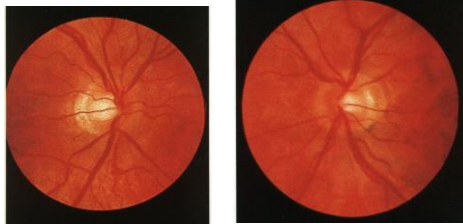
Large physiologic cups



Asymmetry



ONH in Myopia



Any signs of glaucoma?

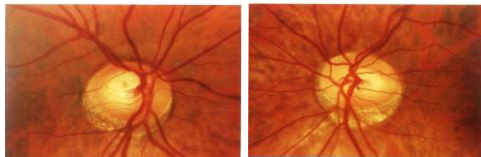


ONH in Myopia

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



Tilted disc syndrome

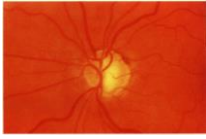


Horizontally oval disc



Signs to look for

Focal atrophy of rim



Barring of circumlunar vessel



Nasal cupping

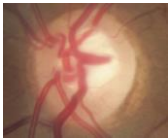


Laminar dots sign

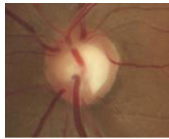


Signs to look for

Bayonetting sign



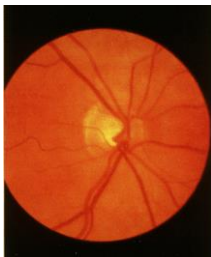
Nerve fiber layer defects



Disc hemorrhage



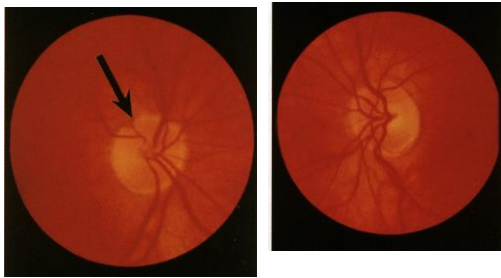
Focal atrophy of neural rim



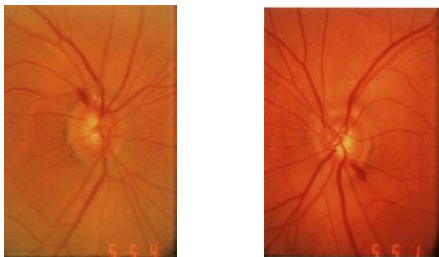
Focal atrophy of neural rim-2



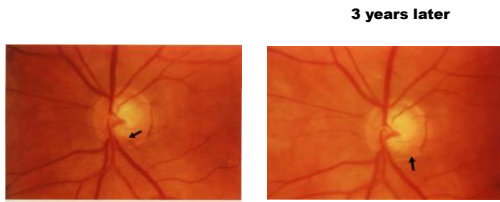
Optic disc hemorrhages



Optic disc hemorrhages-2



Optic disc hemorrhages-3

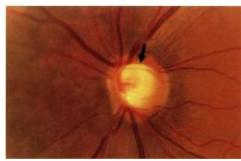


Barring of circumlinear vessels



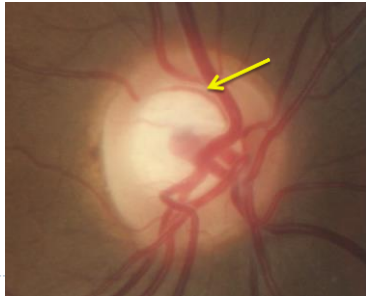
- ▶ Vessels that runs along margin between cup and neural rim.
- ▶ Found supero and infero temporally

Barring of circumlinear vessels

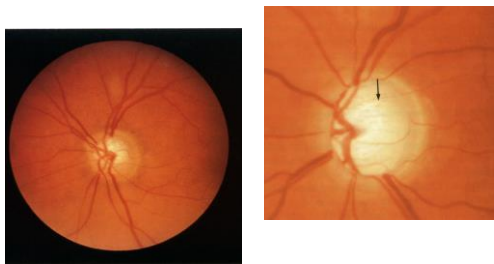


- ▶ As rim becomes thinner it leaves an area of pallor between the rim and the circumlinear blood vessel.

Barring of circumlinear vessels

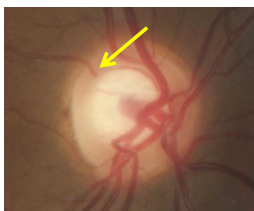


Laminar dot sign



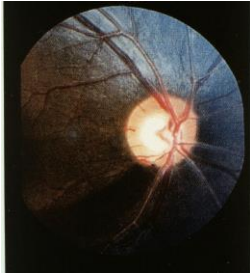
Bayonetting

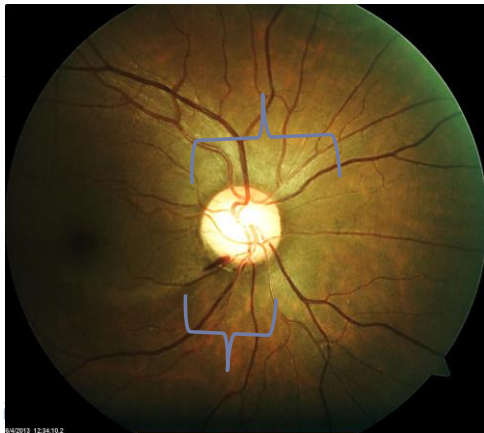
▶ Double angulation of blood vessel.



Nerve fiber bundle defect

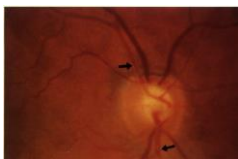
- ▶ Rim changes also produces RNFL defects.
- ▶ Dark stripes or wedge shapes defect paralleling the normal striations.
- ▶ Common after disc hemorrhages





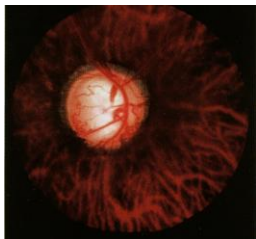
Other vascular signs

- ▶ Proximal constriction of retinal arteries



Other vascular signs

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



Lab worksheet Dr. Pinakin Davey

Disc size
Circle appropriately

Measure retinal disc
Circle appropriately

Retinal nerve fiber layer
Circle appropriately

Pericardial artery

Disc size
Small < 4.0 mm², Medium = 4.0 mm² - 6.0 mm², Large > 6.0 mm²
OD: 4.5, OS: 4.5, OS: 4.5

Measure retinal disc
Circle appropriately

- 1) Paper, not wet perfused (pink) zone
- 2) Not SD
- 3) Not SD

Retinal nerve fiber layer
Diffuse NFL loss
Localized loss

Pericardial artery

- 1) Where
- 2) How much disc diameter

$I/R = \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}$

OD V&V

Vertical: _____

Horizontal: _____

Target: _____

Signs present (absent and where [omit clock hour])

Face asymmetry of neurosis

Recessing sign

Spring of the cornea: absent

Lamina disc sign

Optic disc hemorrhage

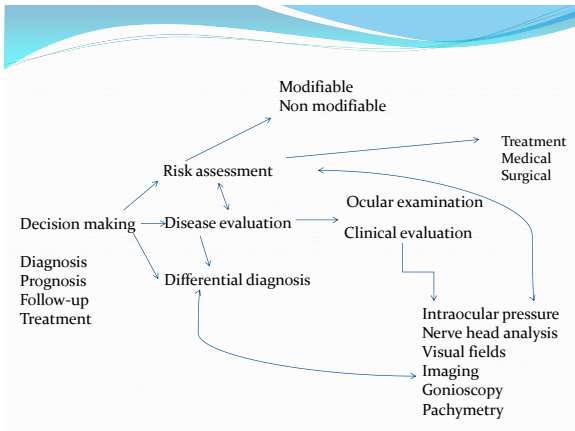
Neurotizing

Positive identification of retinal vessels

Advanced glaucomatous neurotizing

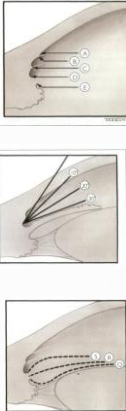
Shunt vessels

Complete glaucomatous optic neuropathy



Gonioscopy

Gonioscopy

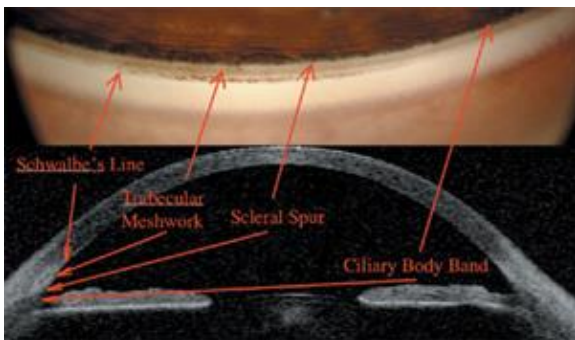


Iris insertion

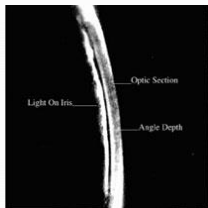
Angle approach

Curvature of peripheral iris

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

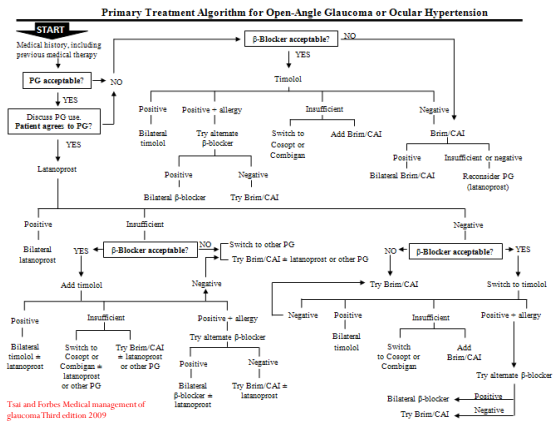
Current practice patterns

- 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

- β -Blockers
 - Timolol
 - Betaxolol
 - Levobunolol
 - Carteolol
 - Metipranolol
- Carbonic Anhydrase Inhibitors (CAIs)
 - Systemic:
 - Acetazolamide
 - Methazolamide
 - Topical:
 - Dichloramide
 - Brinzolamide
- Adrenergic Agonists
 - Nonspecific:
 - Dipivefrin (epinephrine) - also increases conventional outflow
 - α_1 -Agonists:
 - Brimonidine - also increases uveoscleral outflow
 - Apraclonidine - also increases uveoscleral outflow
- Conventional/Trabecular
 - Cholinergic agonists (parasympathomimetics):
 - Pilocarpine
 - Echothiophate iodide
 - Carbachol
 - Prostaglandin derivatives:
 - Bimatoprost
 - Latanoprost
 - Nonspecific adrenergic agonists:
 - Dipivefrin (epinephrine)
- Nonconventional/Uveoscleral
 - Prostaglandin derivatives:
 - Latanoprost
 - Bimatoprost
 - Travoprost
 - α_2 -Agonists:
 - Brimonidine

And how exactly do I use them?



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
 - Complete angle closure

} treated differently
- 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
