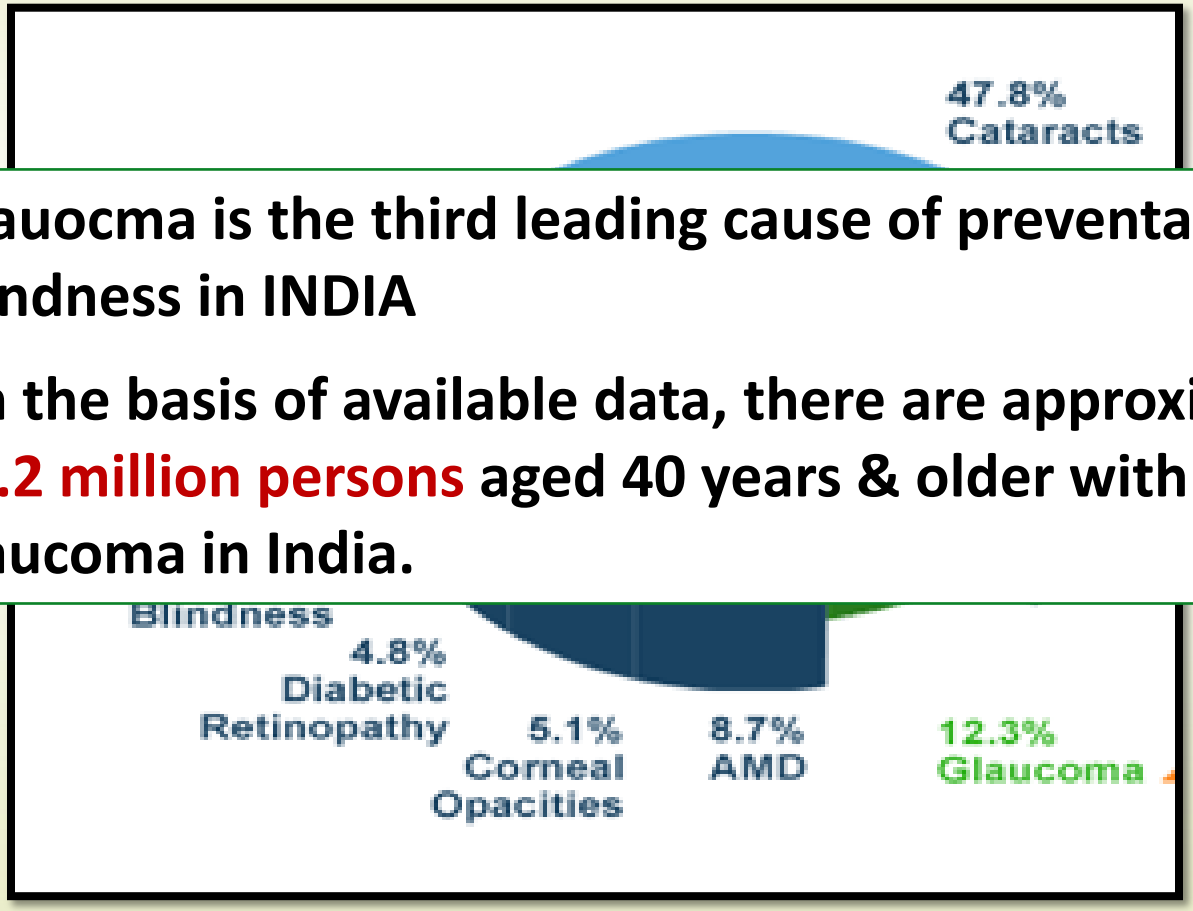
Glaucoma diagnosis

India : Causes of Blindness



- **Glauocma is the third leading cause of preventable blindness in INDIA**
- **On the basis of available data, there are approximately 11.2 million persons aged 40 years & older with glaucoma in India.**

http://www.glaucomaindia.com/. Last accessed 3rd may 2013.

Facts & figures on glaucoma

- Glaucoma was undetected in more than 90% of the individuals identified in population based studies[1].

Detection rates are dependent on the performance of a comprehensive eye examination and on gonioscopy skills.

ve

- Diagnosis rate is less than 10%[2]

- Overall 13.5% were aware of glaucoma[3]

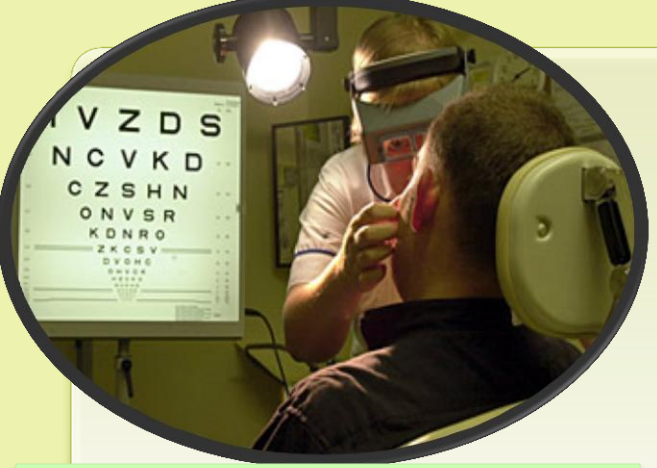
Ref-

1. *Tamil Nadu Journal of ophthalmology.2009;47(4):12-16.*
2. *J Glaucoma. 2010;19:391–397*
3. *Indian J Ophthalmol. 2009 Sep-Oct; 57(5): 355–360.*

Comprehensive eye examination – Basics of glaucoma examination

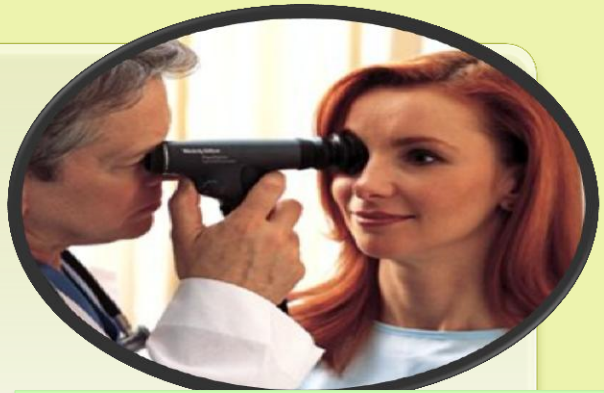
- Comprehensive eye examination and patient history form the basis of an examination for glaucoma,[1] with specific attention to-
  - the evaluation of the optic nerve,
  - potential risk factors for glaucoma,
  - the possibility of secondary glaucomas,
  - concomitant systemic diseases,
  - medications, and
  - subjective symptoms.

1. *Can J Ophthalmol* 2009;44(Suppl 1):S1–S93.
2. *Can J* Ophthalmol 2007;42:39–45.



Refraction- test short/long sighted vision .

Tonometry- measure IOP.

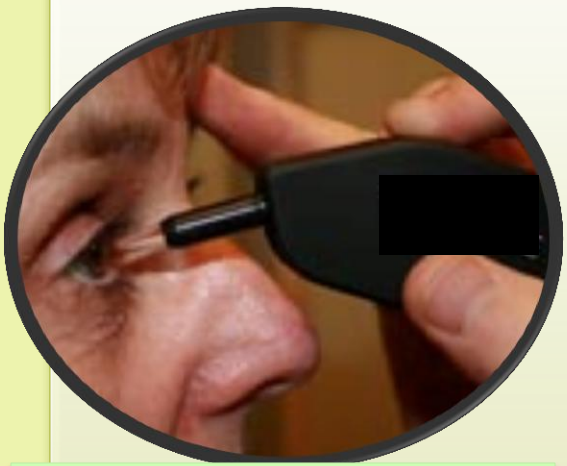


ophthalmoscope- examine interior of eye. (lens, retina, optic nerve)

History

Diagnosis

Slit-lamp examination.

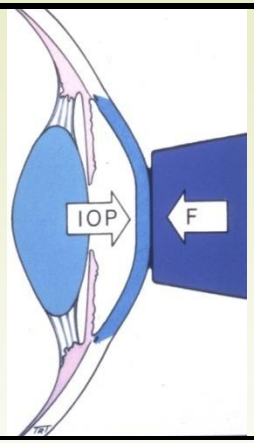
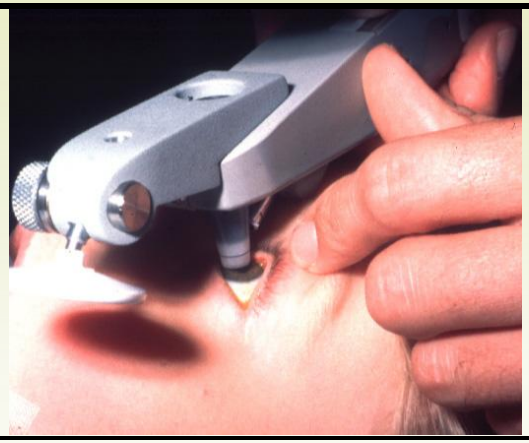
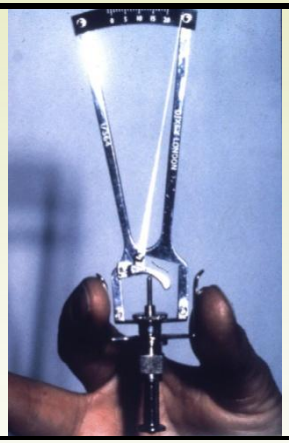


Pachymetry-measure corneal thickness.

gonioscopy-measure irido-corneal angle.

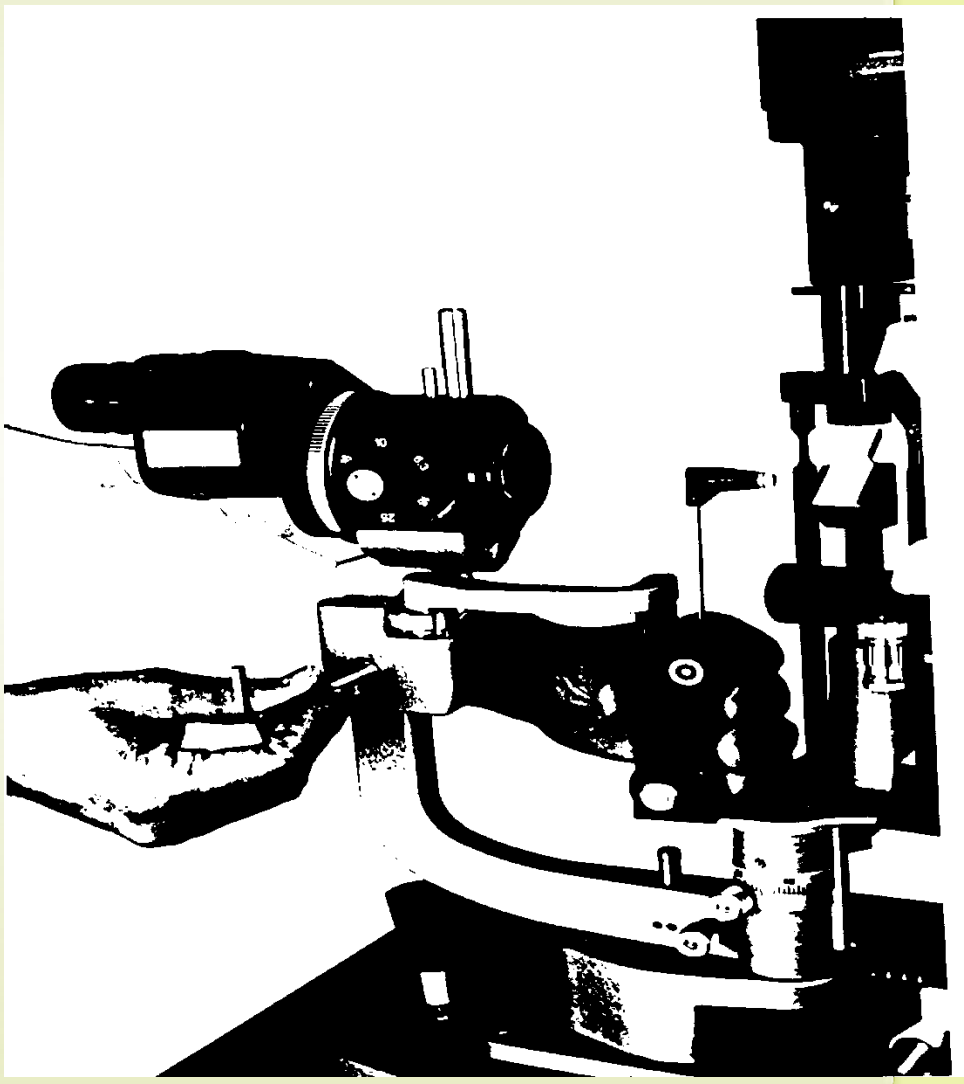
Perimetry-measure extent of vision loss.

Tonometers

		
Goldmann Contact applanation	Perkins Portable contact applanation	Schiotz Contact indentation
		
Air-puff Non-contact indentation	Pulsair 2000 (Keeler) Portable non-contact applanation	Tono-Pen portable contact applanation

Goldmann applanation tonometry (GAT) – Gold standard

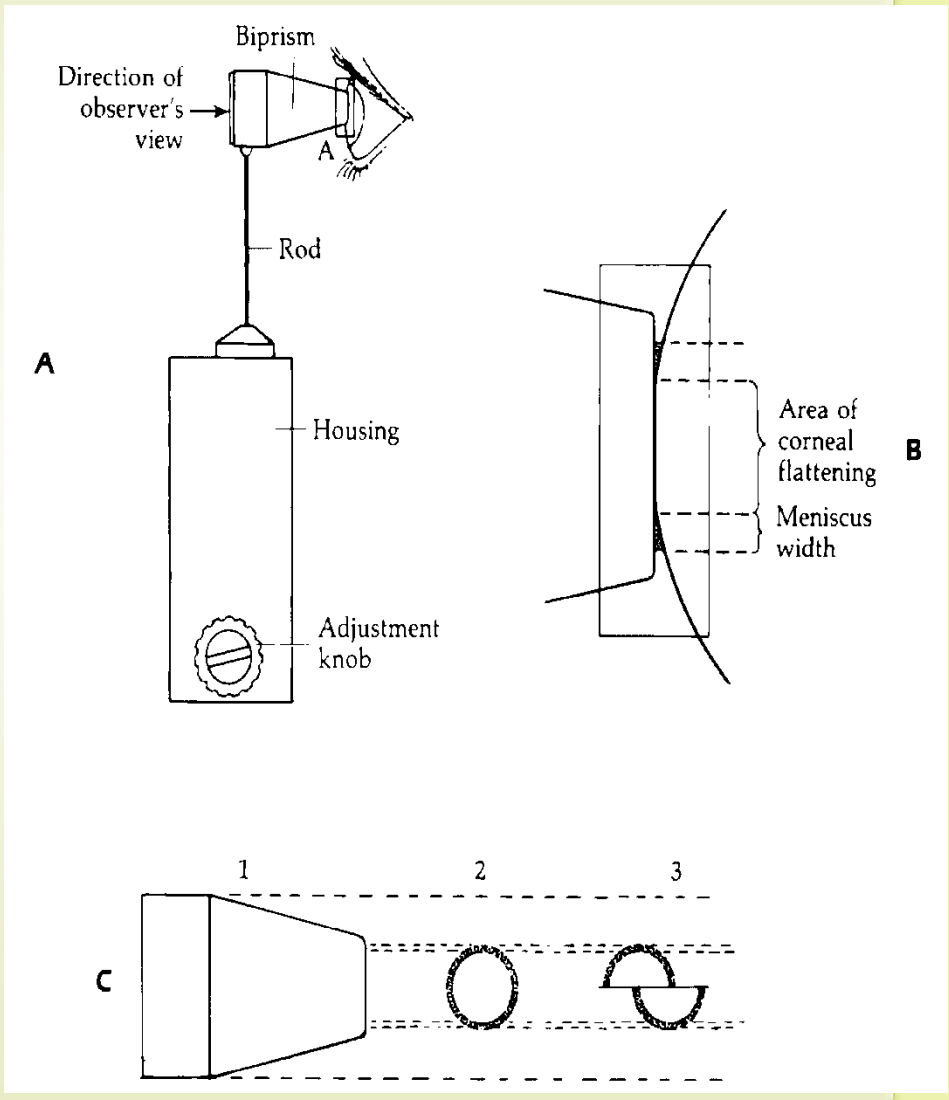
- Gold standard against which others measured.
- Good accuracy in gas-filled eyes.
- Inter- and intraobserver variability (>30% varied by 2-3 mmHg), due to subjective nature of optical endpoint.
- Assume error of 2 mmHg.



http://www.google.co.in/url?url=http://webeye.ophth.uiowa.edu/dept/resfelo/goals/videos/Tests%26devices/Goldmanntonometry.ppt&rct=j&frm=1&q=&esrc=s&sa=U&ei=GO20U-jGHMihugT39oGYCA&ved=0CCEQFjAC&usg=AFQjCNGbfQCJ7jABvgjULx_Q9_6pxISkhg. Last accessed 3rd July 2014.

Technique of measurement

- Plastic biprism contacts cornea creates two semicircles
- Edge of corneal contact is visible after placing fluorescein into tear film & viewing with cobalt blue light
- Manually rotate the dial calibrated in grams, force is adjusted by changing the length of a spring within the device.
- Inner margins of semicircles touch when 3.06 mm of cornea is applanated.



Instructions to patient

- Press head firmly against chin and forehead rest.
- Look straight ahead and fixate on a target (e.g. examiners opposite ear)
- Breathe normally, do not hold your breath
- Blink immediately prior to measurement to moisten cornea.

Errors in Measurement

- The fluorescein ring is too wide or too narrow:
- Too wide: occurs if prism not dried after cleaning or lids touch prism. **Overestimates** IOP. Solution: dry prism
- Too narrow: inadequte fluorescein concentration may cause hypofluorescence. **Underestimates** IOP. Solution: patient blinks or additional fluorescein added.

Errors (cont.)

- Thin corneas produces **underestimate**
- Thick cornea d/t increased collagen gives **overestimate**, if d/t edema gives **underestimate**.
- Inadequate vertical alignment of semicircles leads to **overstimate** of IOP.
- Distortion d/t irregular cornea influences accuracy, less useful with corneal scarring.

Errors (cont.)

- Squeezing of eyelids, breath holding or other Valsalva maneuvers, pressure on globe, excessive EOM force applied to restricted globe, vertical gaze, tight collars, retreating patient, inaccurately calibrated tonometer.
- Repeated tonometry may induce decline in estimated IOP.

Error d/t corneal curvature

- Increase of 1 mmHg for every 3D increase in corneal power.
- More fluid displaced under steep cornea, increases contribution of ocular rigidity in overestimating IOP.
- The steeper the cornea, the more cornea must be indented to produce standard area of contact.
- >3D astigmatism produces elliptical rather than circular area

Correction for astigmatism

- With semicircles displaced horizontally, IOP **underestimated** by 1 mmHg for every 4D of WTR astigmatism, vice versa for ATR astigmatism.
- To minimize, prisms should be rotated so that axis of least corneal curvature is opposite red line on prism holder (i.e. align **negative** cylinder axis).
- Can average reading with vertical and horizontal alignment of prism.

Sterilization

- CDC recommendation (HIV, HSV, and adenovirus): wipe tip clean and disinfect tip only with bleach (1:10 dilution x 5”, changed once daily).
- Alternative is 3% H2O2, changed at least twice daily (affects tip less than bleach or ETOH).
- Alternative #2: wiping tip with 70% ETOH

Gonioscopy

- Fundamental part of ophthalmic evaluation
- Conformation of normal angle structures
- Determination of narrowness or closure of anterior chamber angle
- Grading of angle width
- Pathological findings
- Needs to be performed routinely to avoid misdiagnosis

http://www.apglaucomasociety.org/toc/Gonioscopy(NM).pdf. Last accessed 3rd July 2014.

Direct Gonioscopy

The anterior curve of the goniolens is such that the critical angle is not reached, and light rays are refracted at the contact lens- air interface

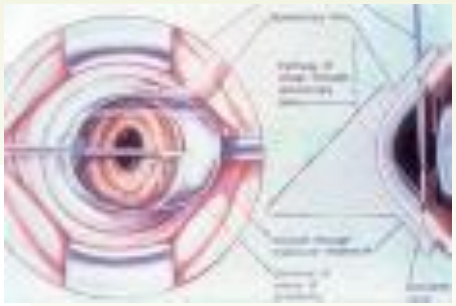
EG: Koeppe, Shaffer, Layden, Barkan, Thorpe, Swan Jacob

Advantages: An erect and panoramic view.
Can be performed on both eyes simultaneously.

Disadvantages: Difficulty of learning technique. Instrumentation expensive and difficult to obtain.
Less magnification
Also need for the patient to be supine.

Uses: Surgical goniolenses used at the time of angle surgery, e.g. goniotomy, and for Gonioscopy in infants for diagnostic purposes.

Various Diagnostic Gonio Lenses and Specifications



Direct Goniolenses:

-***Koeppe***- Prototype

-***Shaffer***. – small Koeppe lens(infants)

-***Barkan***- prototype surgical goniolens

-***Thorpe***- surgical and diagnostic lens.

-***Swan Jacob***- surgical goniolens for children

INDIRECT Gonioscopy:

- The light rays are reflected by a mirror/ prism in the contact lens and leave the lens at nearly a right angle to the contact lens- air interface

- Eg: Goldmann single, and three mirror lenses, Ziess four mirror lenses, posner and susmann four mirror lenses, Thorpe four mirror, Ritch trabeculoplasty lens

Indirect goniolenses:

Goldmann single mirror- mirror inclined at 62 degree for gonioscopy.

Central well- dia of 12 mm, post radius of curvature of 7.38 mm

Goldmann three mirror- 59 degrees

Zeiss four mirror- all four mirrors inclined at 64 degree**.**

Ritch trabeculoplasty lens.

Four mirror lenses- Ziess type:

Allows quick evaluation of angle structures.

- No coupling solution necessary.
- Enables differentiation between appositional (reversible) and synechial angle closure

Disadvantages:

- Mastery of proper technique requires skill and practice.
- Tendency to underestimate the narrowness of the angle; it is difficult to avoid inadvertently applying pressure to the central cornea,thus artificially widening the angle.

Goldmann type lenses:

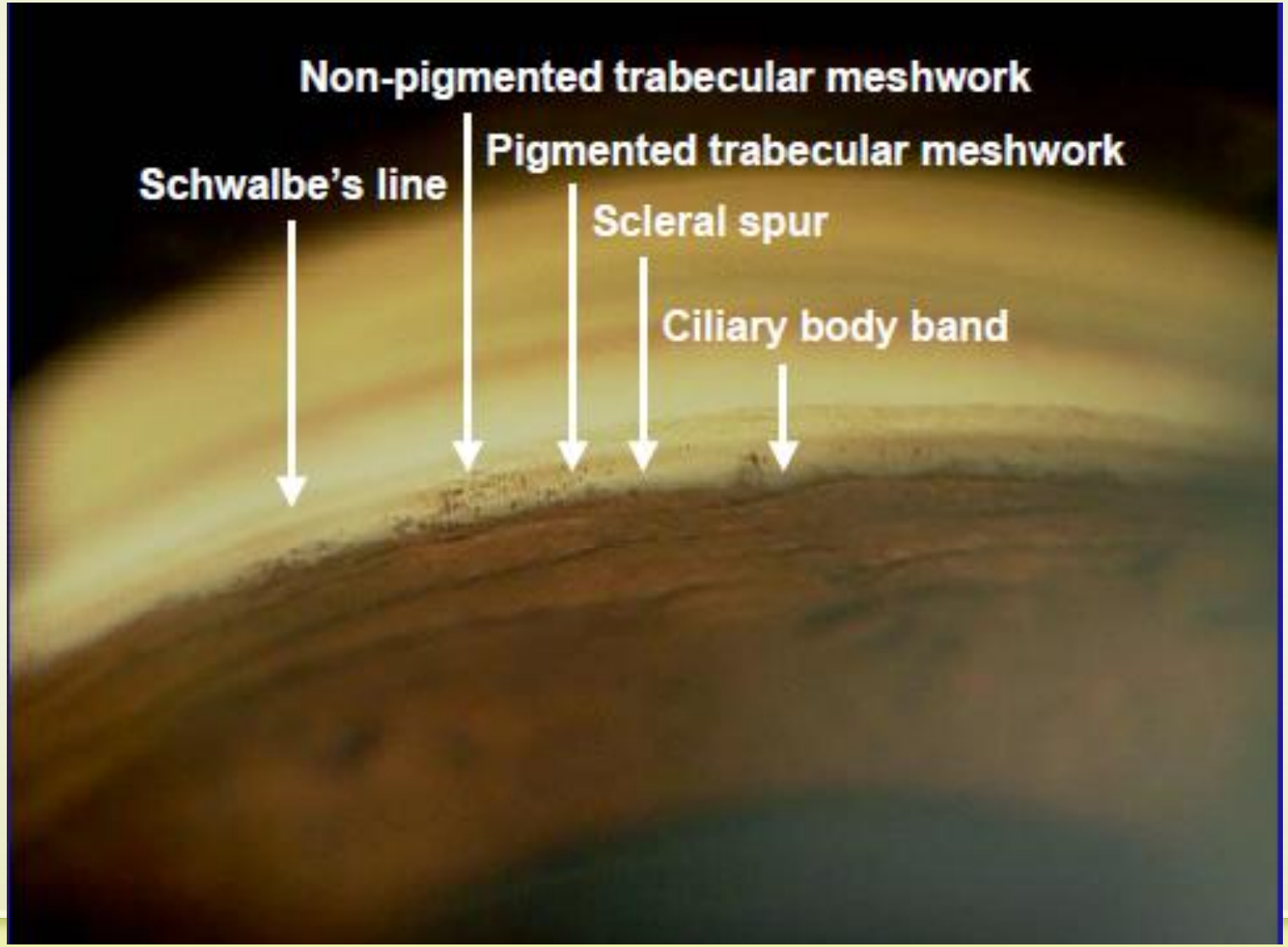
- Ease in learning technique and less expensive.
- Greater visibility of detail than with the Koeppe technique because of higher magnification.
- Therefore, it is better for detection of details such as subtle neovascularization in the angle.
- Stability of lens over cornea better.

Disadvantages: Cannot perform dynamic, or indentation Gonioscopy.

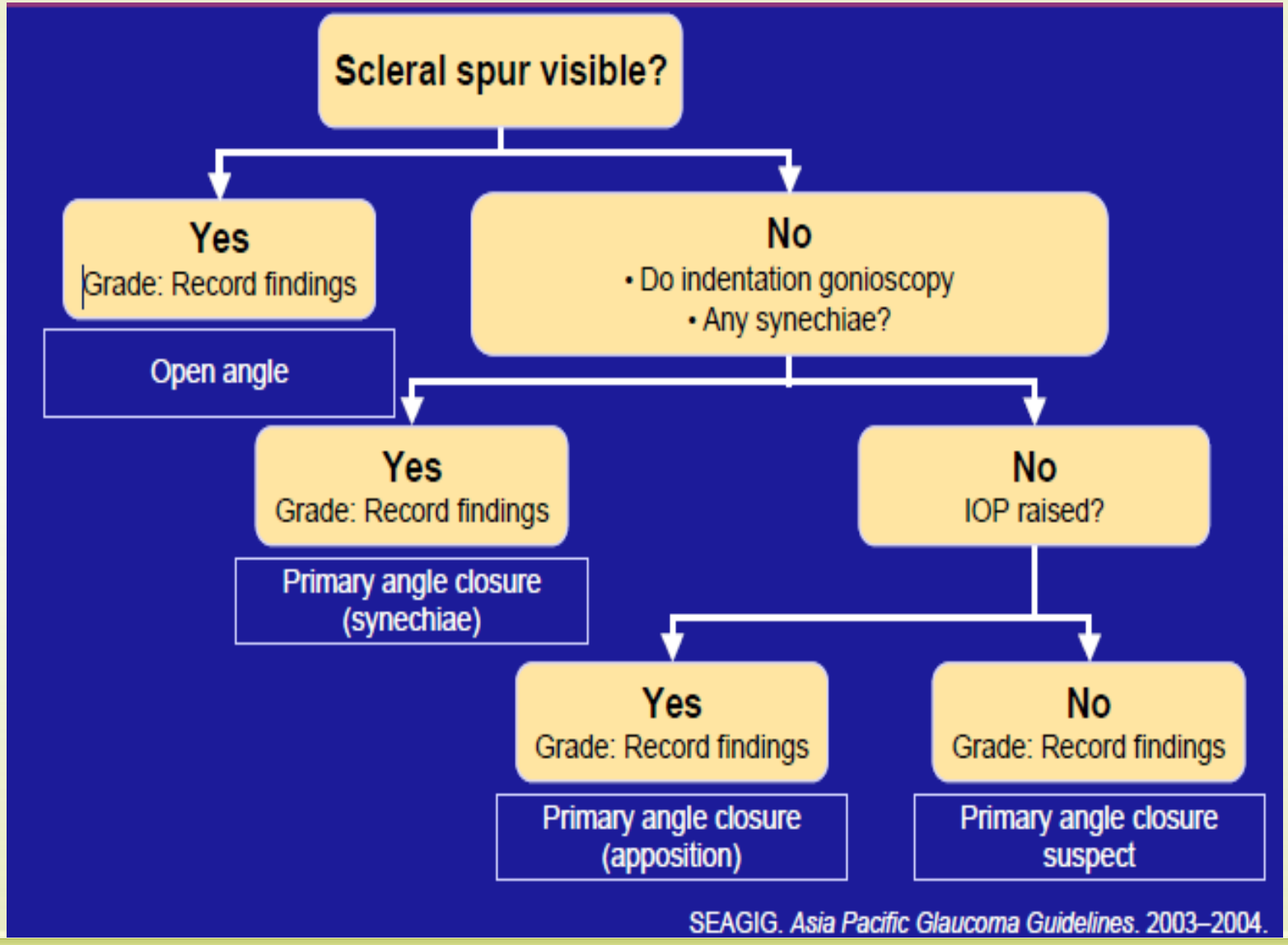
How to do Gonioscopy?

- Anesthetize the cornea.
- Insert the lens with or without coupling device.
- Short beam of light, avoid illuminating the pupil
- To manipulate - ask patient to look in the direction of the mirror
- Indent the cornea with a four mirror lens (appearance of Descemet's folds)

Normal angle structures



Gonioscopy flow diagram



Grading of angle width:Shaffer and modified Shaffer system

	Grade 0	Grade I	Grade II	Grade III	Grade IV
Shaffer	Closed	10°	20°	30°	40°
Modified Shaffer	Schwalbe's line not visible	Schwalbe's line visible	Anterior TM visible	Scleral spur visible	Ciliary band visible

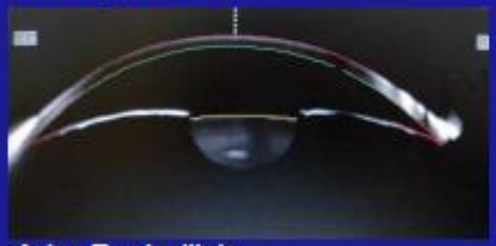
Red = higher risk
Yellow = medium risk
White = lower risk

SEAGIG. *Asia Pacific Glaucoma Guidelines*. 2003–2004.

Other ways to evaluate the anterior chamber angle

Scheimpflüg photography

Asian Eye Institute



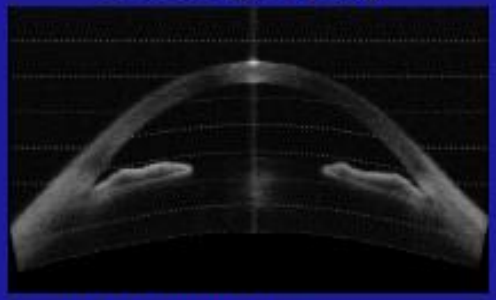
Asian Eye Institute

Ultrasound biomicroscopy

Asian Eye Institute

Chew PTK, Aquino MC

Anterior segment optical coherence tomography



Chew PTK, Aquino MC

Optic Disc Evaluation

- **Slit lamp biomicroscopy : Ideal**
  - Stereoscopic View –Cupping
  - Measuring the optic disc size
- **Direct Ophthalmoscopy**
  - Good Magnification
- **Indirect Ophthalmoscopy**
  - Overall View
- **Optic disc Photoghraphy.**
  - Documentation, Monitoring for progression.

The 7 parameters to look for…

1) **Disc:** Size and Shape

2) **Neuroretinal Rim (NRR)**:

- Size,Shape,Pallor
- ISNT rule

3) **Cup:** Size and Shape in *relation* to the optic disc size,

-Vertical C/ D Ratio, Cup depth / Excavation

4) **Optic Disc Hemorrhage:** Presence & Location

The 7 parameters to look for…

5) Nerve Fibre Layer Defect:

- **focal & diffuse**

6) Para Papillary Atrophy;

- **Size,location & Configuration**

7) Retinal Arterial Attenuation:

- **focal & diffuse**

All these variables can be measured semiquantitavively by ophthalmoscopy without applying sophisticated techniques

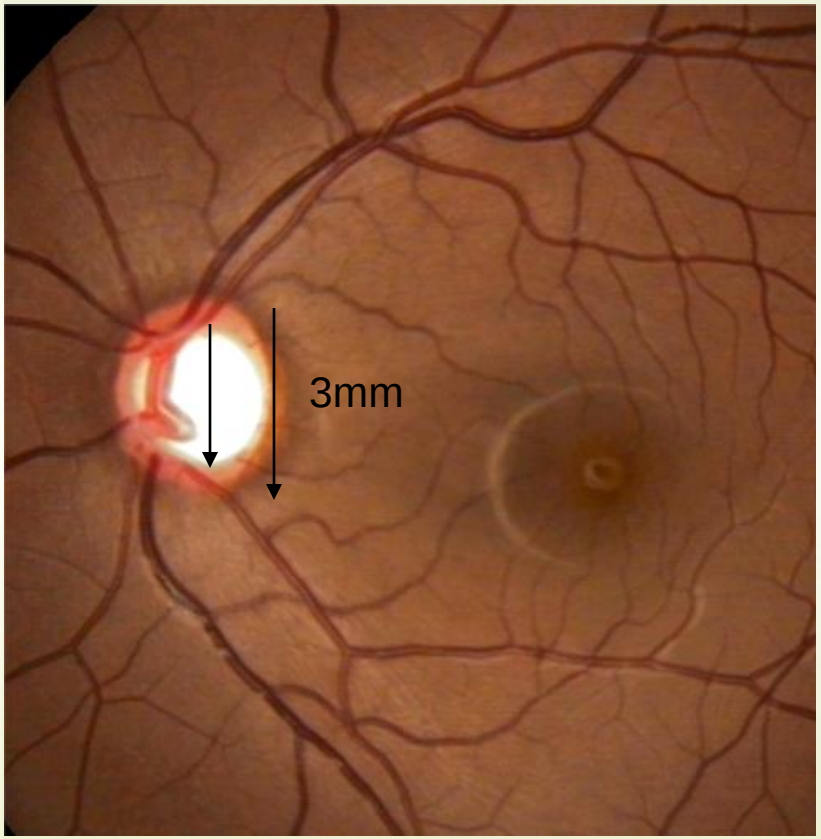
1)Optic Disc: Size & Shape

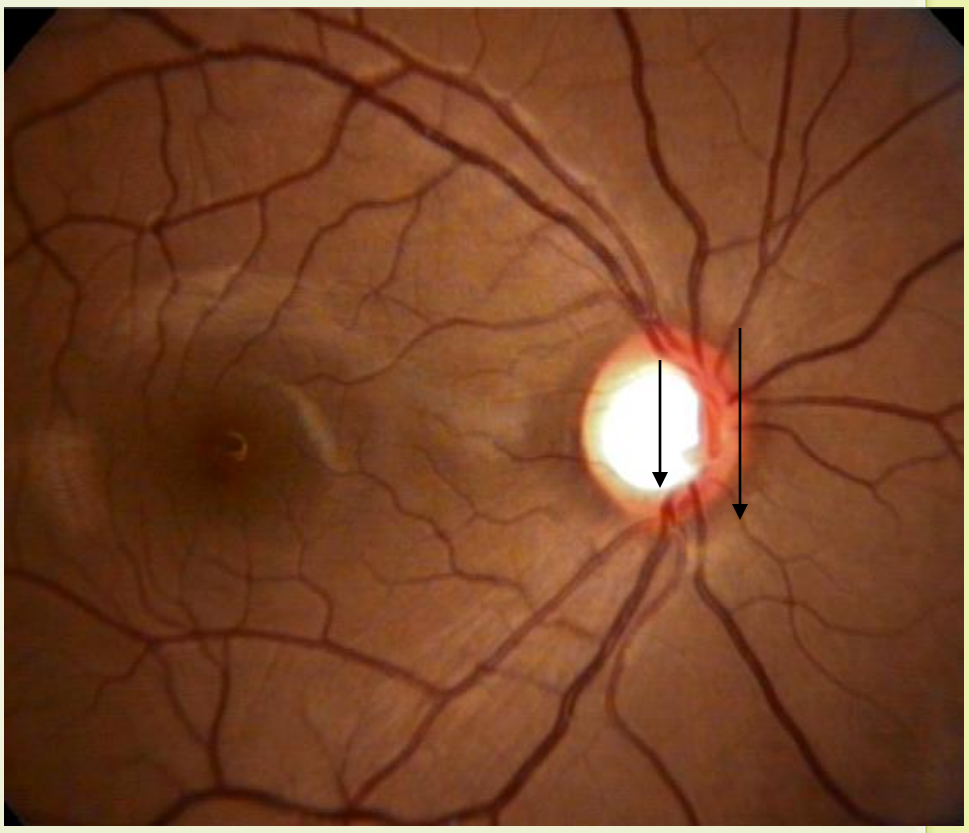
- Determining the size of the disc =Crucial
  - Helps to differentiate Physiological cupping from Pathological.
    - Large discs have big physiological cups.
    - Small Discs have small cups or no cups
- Measurement of Vertical Disc diameter :
  - Length of the vertical beam of slit lamp light
  - Multiplied by correction factor of the condensing lens
  - Volk 60 D= X 1
  - Volk 90D= X 1.5

Cup: Size, Shape, location in relation to the disc size

- Optic Cup= Excavation in the optic nerve head
  - Stereoscopic evaluation
- In normal eyes= Areas of optic disc & Optic cup are corelated
- Large optic discs=Large cup
- Small optic disc =Small cup or no cup
- Early & moderate glaucomatous damage in small disc may be missed because of the erroneously low cup disc ratios

Large Disc=Large Cup

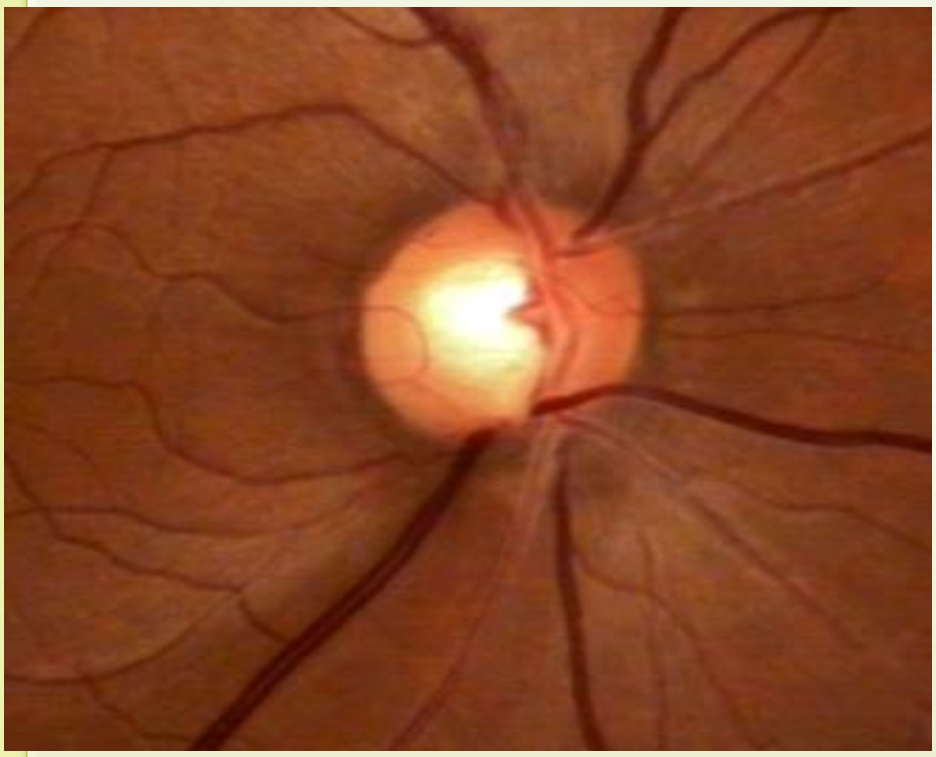




Vertical Cup Disc Ratio

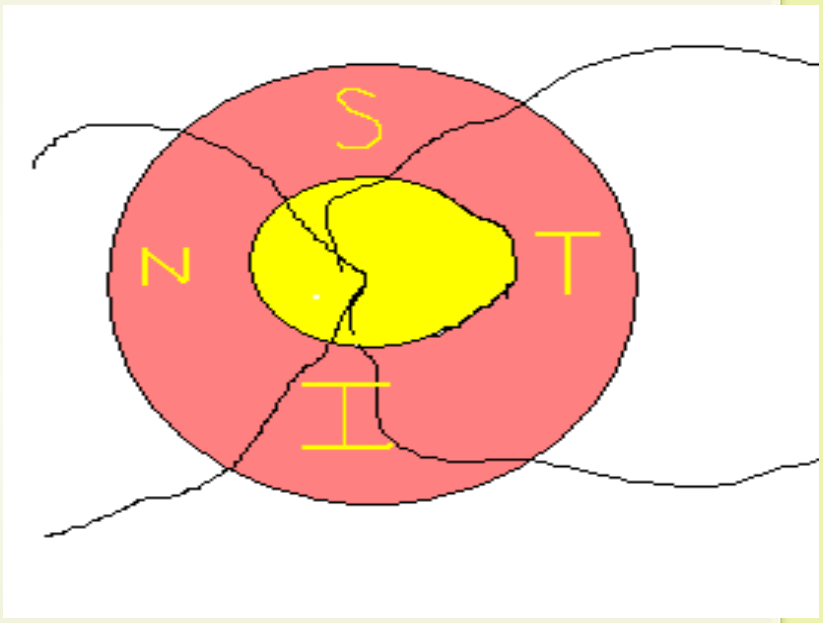
- Vertically oval optic disc
- Horizontally oval optic cup
- In normal eyes: Horizontal CD ratio **>** than vertical CD ratio
- In Glaucomatous eyes: Vertical CD ratio **>** than the horizontal CD ratio

Vertical CD ratio

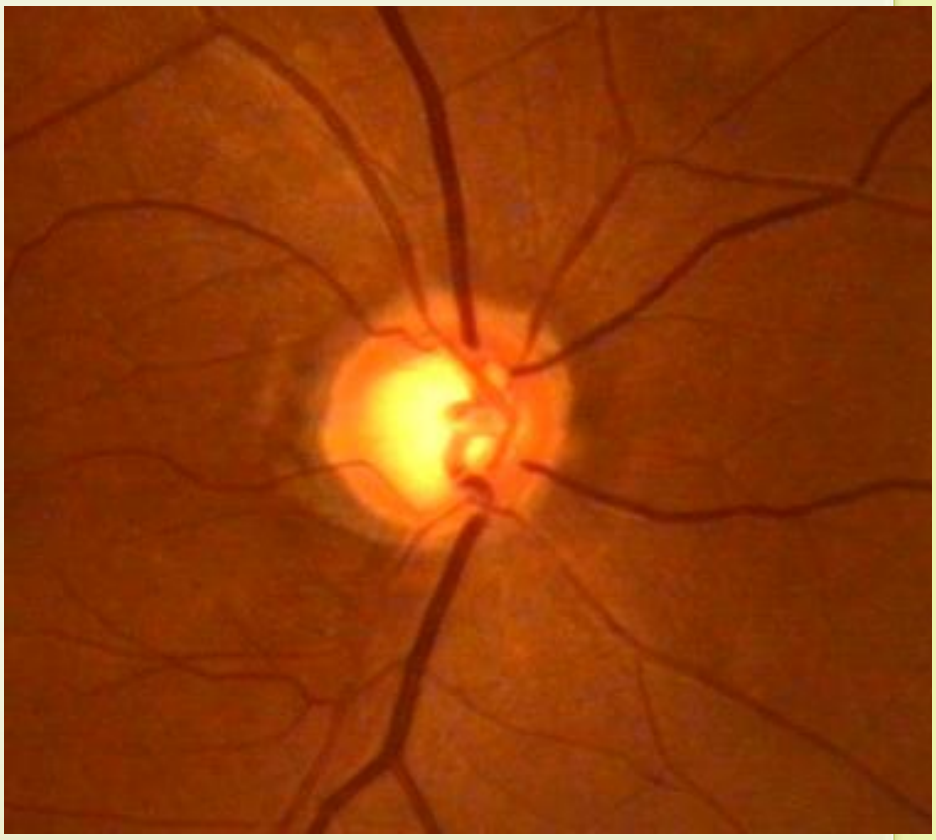


The Neuroretinal Rim

- Size, Shape, Pallor.
- The ISNT rule:



- Thinning of the NRR
- Pallor of NRR
- Notching:
  - A notch is a localized defect in the Neuroretinal rim on the cup side of the rim

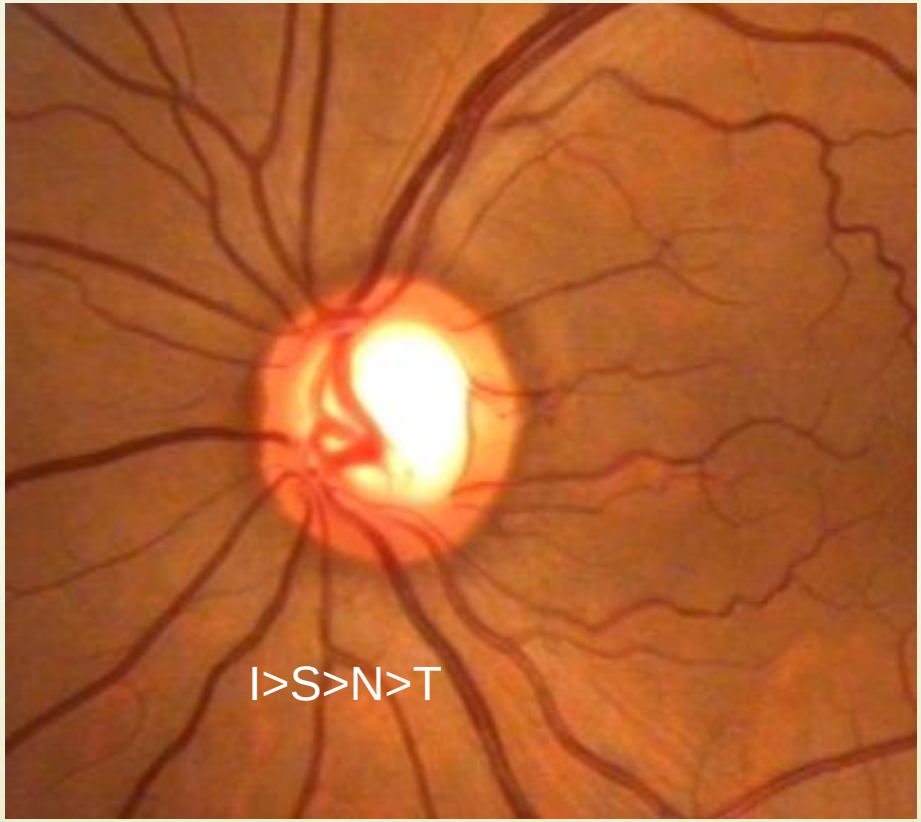


The Neurretinal rim loss in Glaucoma

- Usual sequence of NRR loss in Glaucoma:
  - Inferotemporal
  - Superotemporal
  - Horizontal temporal
  - Inferonasal
  - Superonasal

- In contrast,in the non glaucomatous optic nerve damage, the NRR is not always affected and hence contour of NRR is maintained.

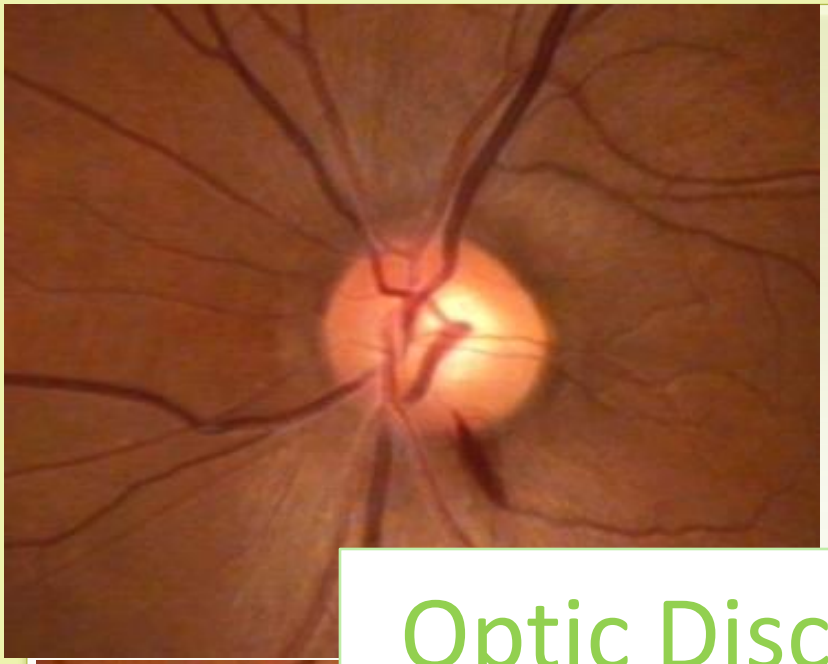
NRR , the “ISNT Rule”



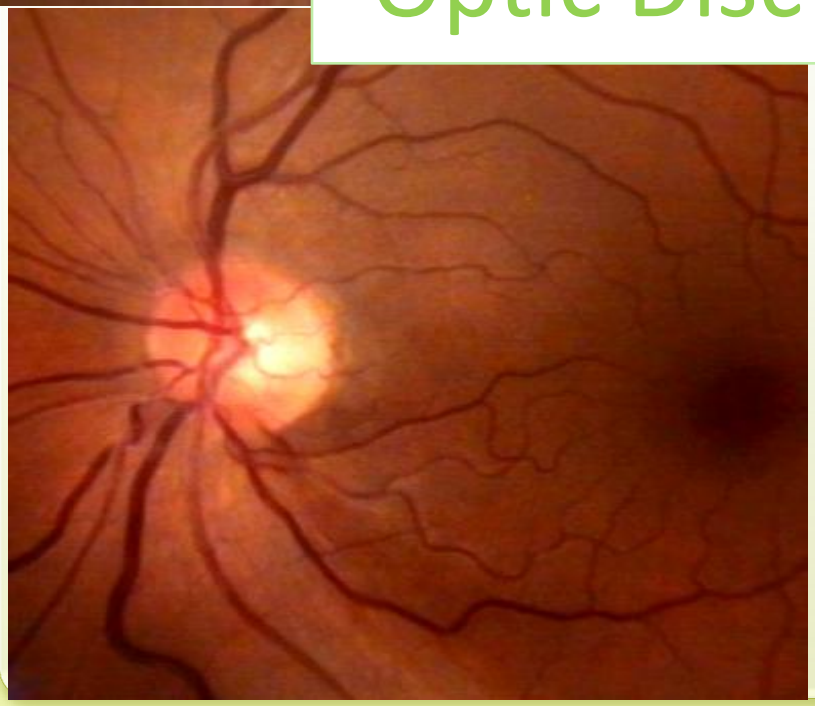
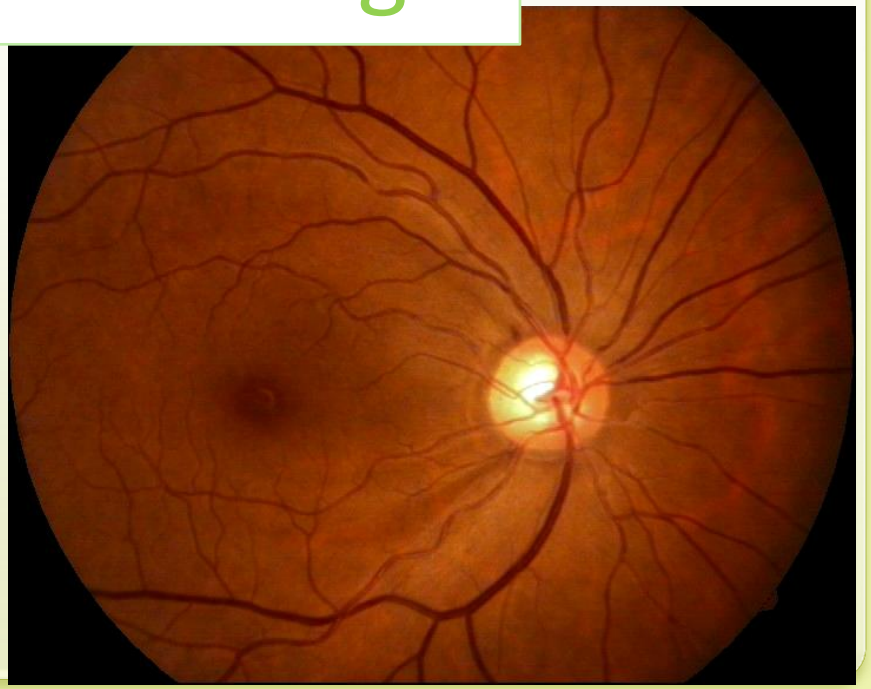
`kindly elaborate little more on the ISNT rule.

Optic Disc Hemorrhage

- Splinter or Flame shaped hemorrhages
- At the margin of the disc
- **Hallmark** of *Glaucomatous* optic nerve damage
- 4 to 7 % of eyes with galucoma
- Found in early & moderately advanced Glaucoma and rare in very advanced stage
- Located usually in the inferotemporal & superotemporal disc margins
- Associated with localized RNFL defect and neuroretinal rim notches .
- Suggests *Progression.*
- More common in NTG




Optic Disc Hemorrhage

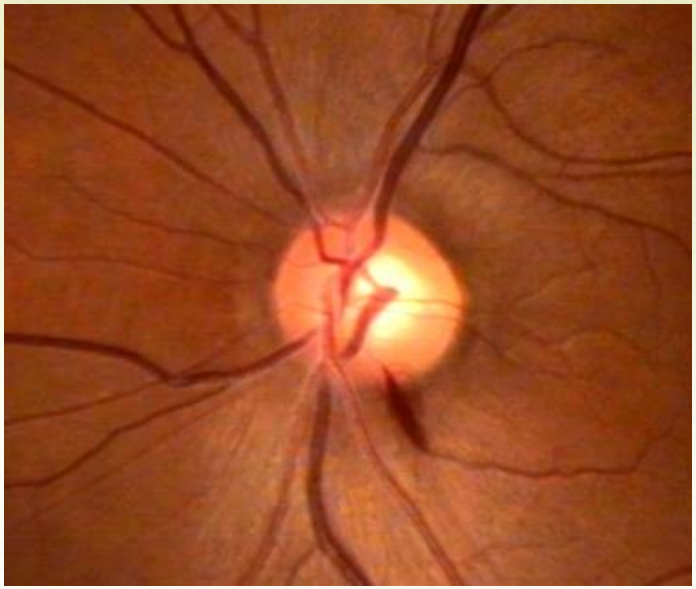
Retinal Nerve Fibre Layer Defect

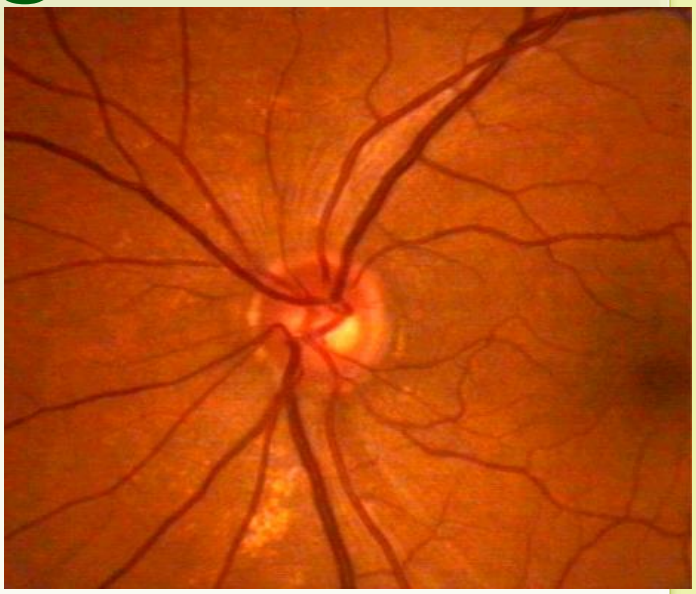
- RNFL contains retinal ganglion cells axons covered by astrocytes and bundled by processes of muller cells
- Seen as bright fine striations fanning off from the disc to the periphery.
- Dilated pupil, green light, clear optical media aids the evaluation of RNFL

Retinal Nerve Fibre Layer Defect

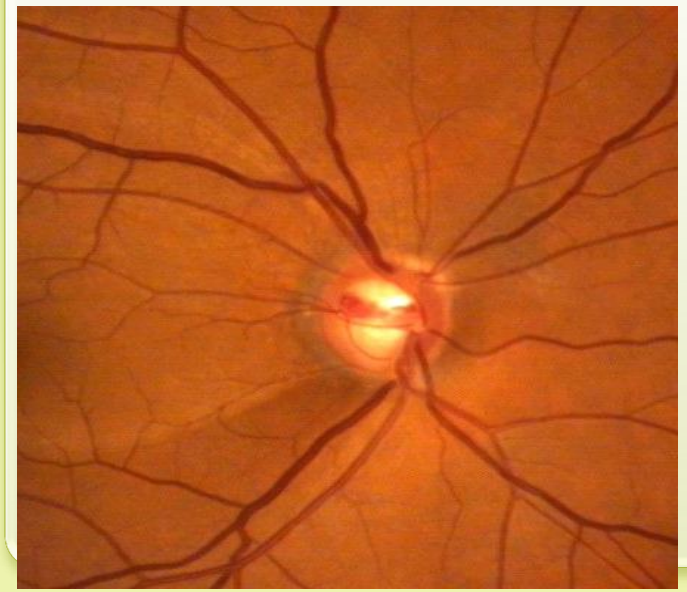
- Localized RNFL defects:
  - Can be detected before visual field defect has developed
  - Focal type of NTG
  - Early to medium advanced Glaucomatous damage
- Diffuse loss of RNFL:
  - More difficult to detect
  - Peripapillary retinal vessels appear bare
  - Underlying Choroidal vessels more clearly seen

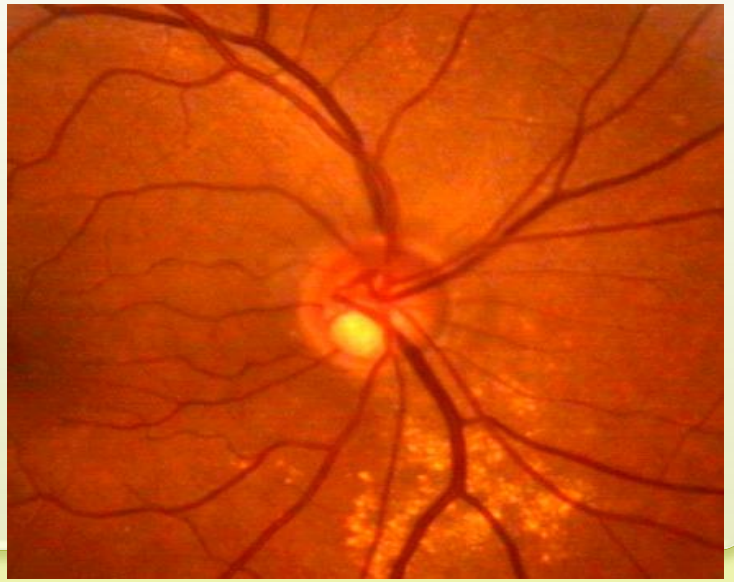
Early Damage



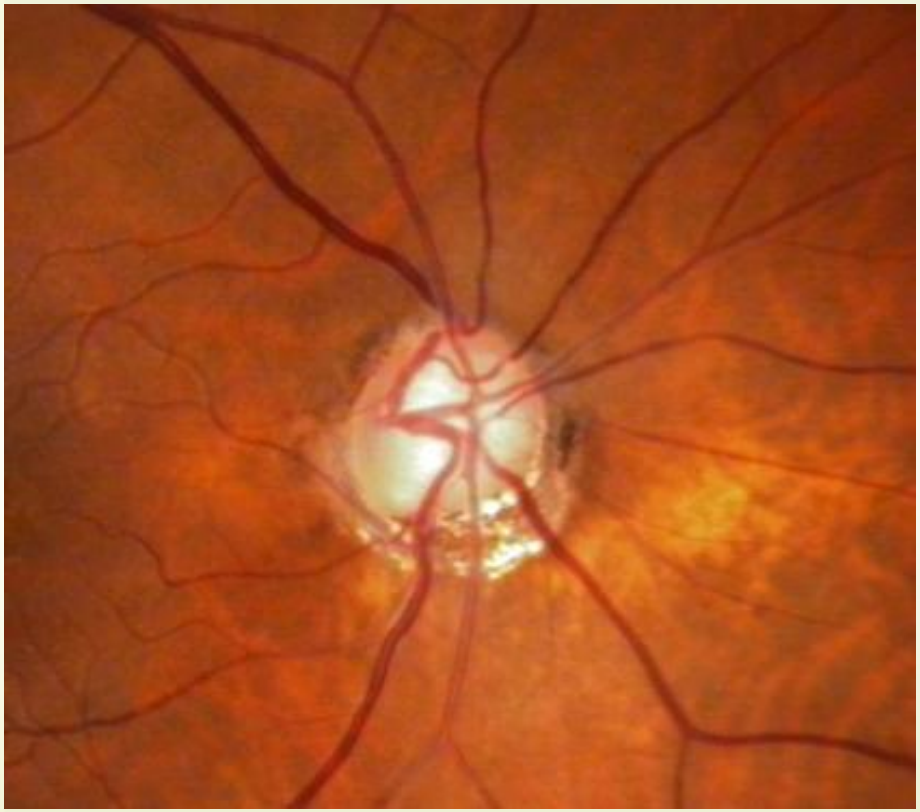


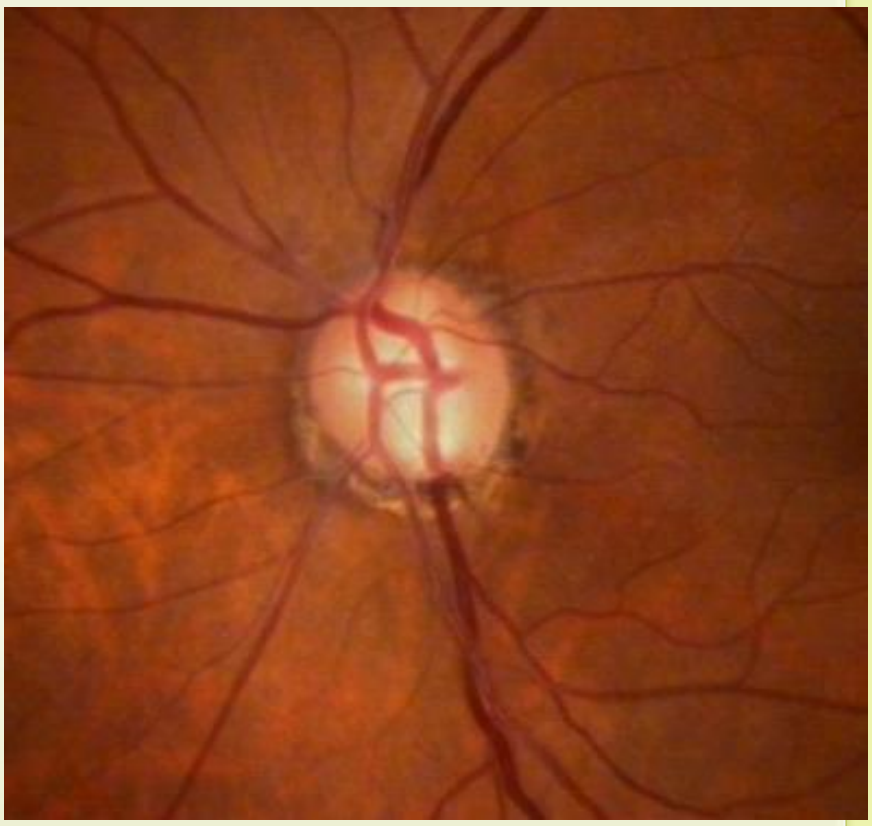
Moderate damage





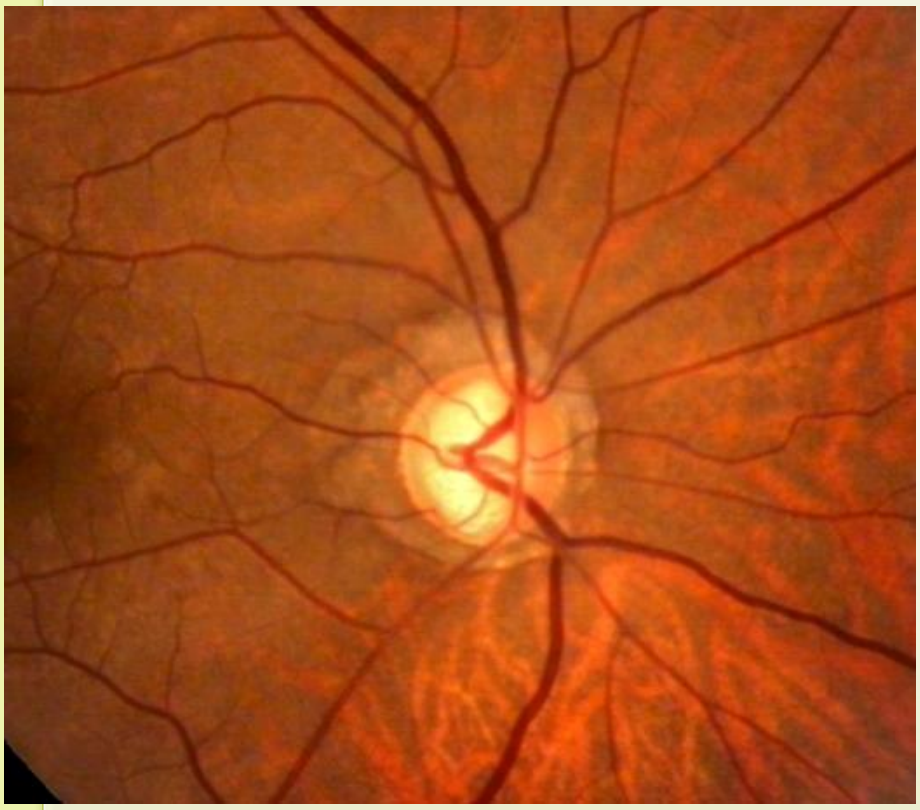
Advanced

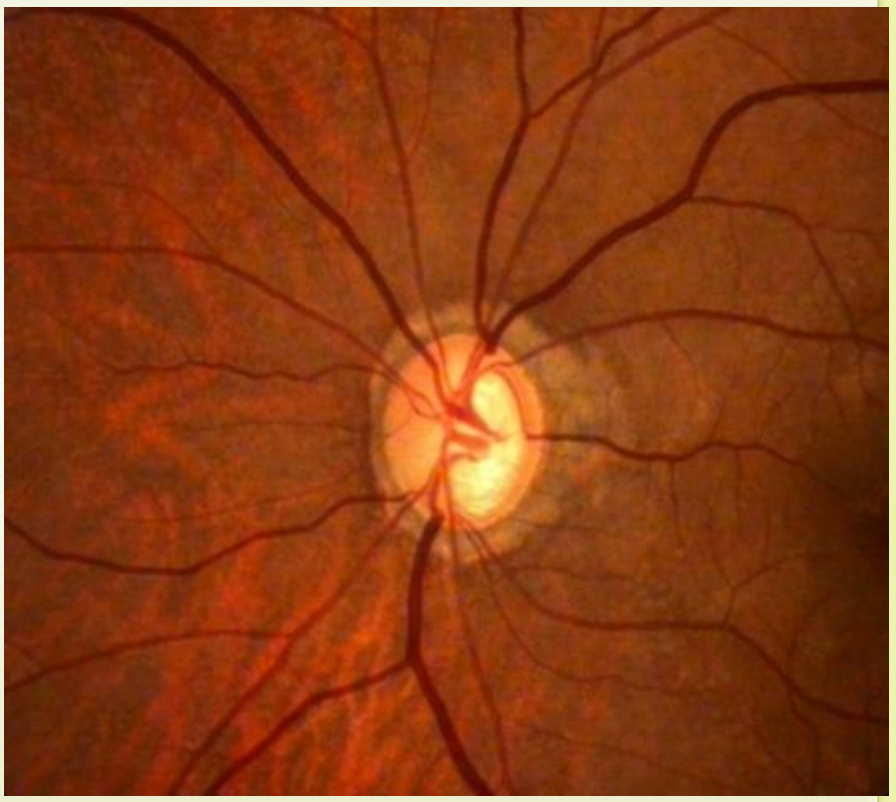


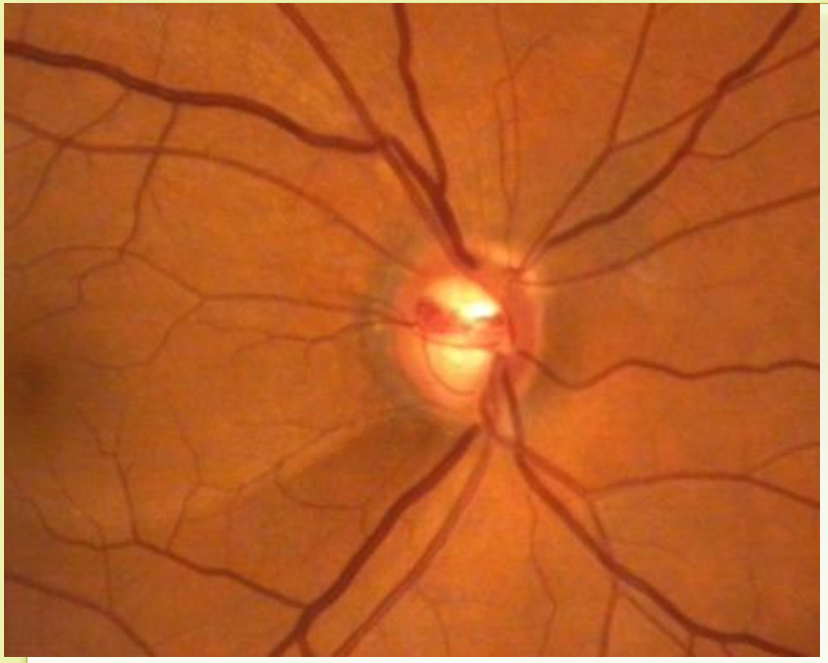
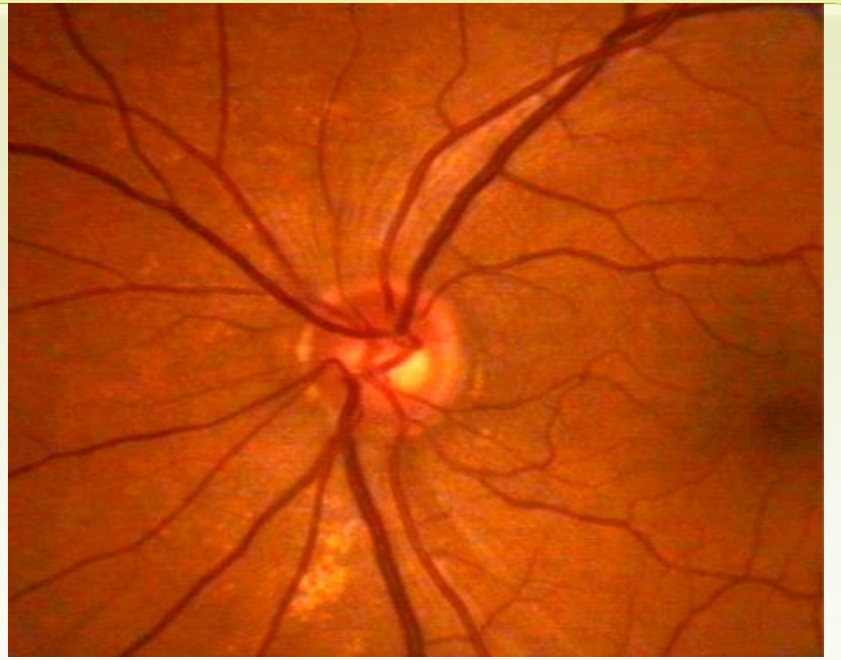
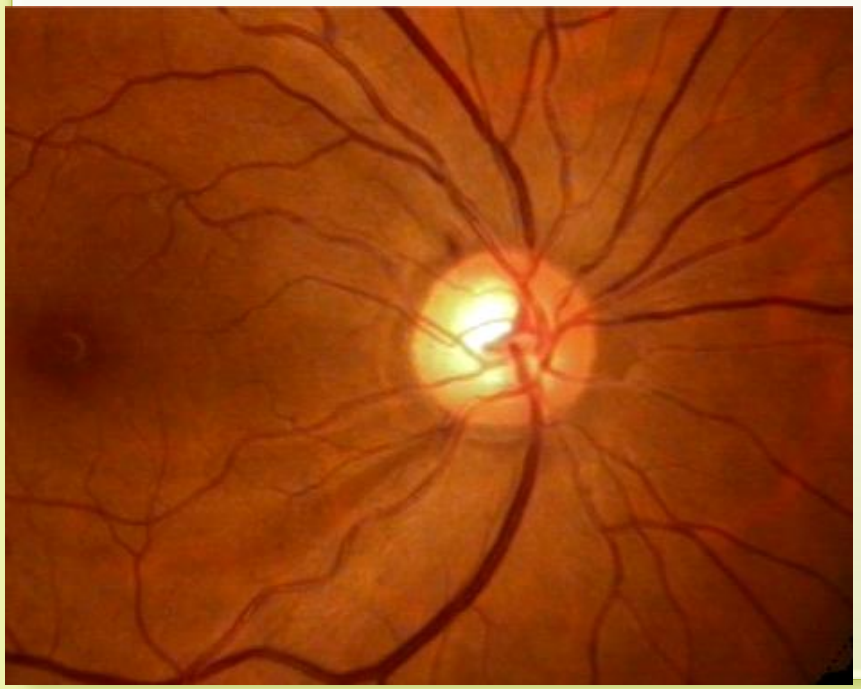
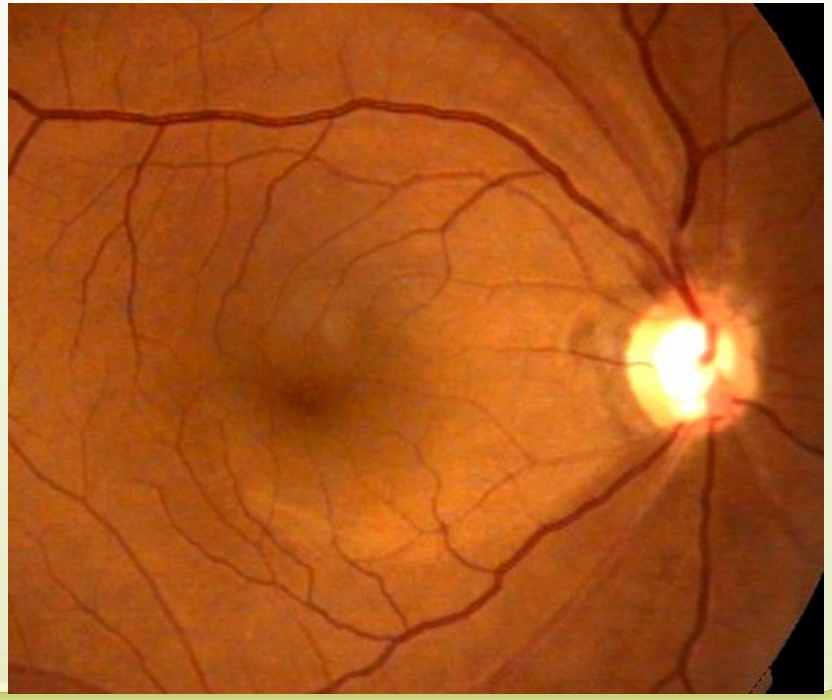


Both the poles affected

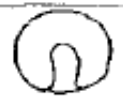
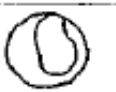
Advanced…





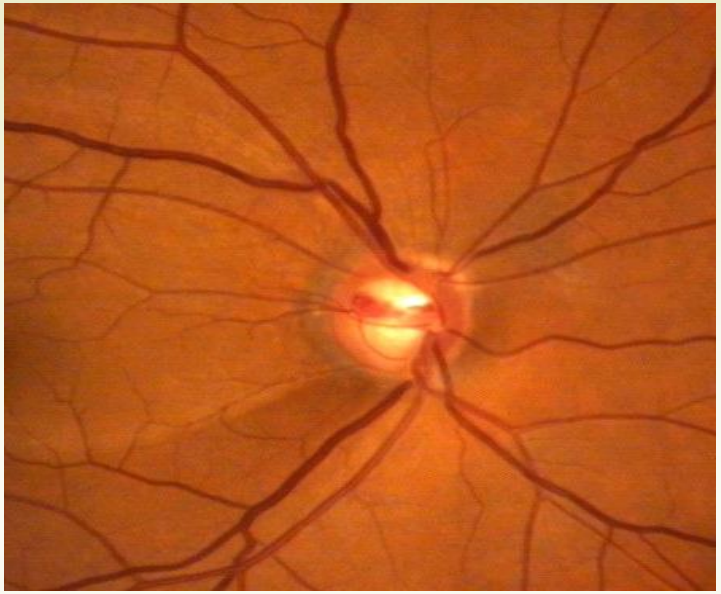





Disc Damage Likelihood Scale

	Narrowest width of rim (rim/disc ratio)				Examples		
DDLS Stage	For Small Disc <1.50 mm	For Average Size Disc 1.50-2.00 mm	For Large Disc >2.00 mm	DDLS Stage	1.25 mm optic nerve	1.75 mm optic nerve	2.25 mm optic nerve
0a	.5 or more	.4 or more	.3 or more	0a			
0b	.4 to .49	.3 to .39	.2 to .29	0b			
1	.3 to .39	.2 to .29	.1 to .19	1			
2	.2 to .29	.1 to .19	less than .1	2			
3	.1 to .19	less than .1	0 for less than 45°	3			
4	less than .1	0 for less than 45°	0 for 46° to 90°	4			
5	0 for less than 45°	0 for 46° to 90°	0 for 91° to 180°	5			
6	0 for 46° to 90°	0 for 91° to 180°	0 for 181° to 270°	6			
7a	0 for 91° to 180°	0 for 181° to 270°	0 for more than 270°	7a			
7b	0 for more than 180°	0 for more than 270°		7b			

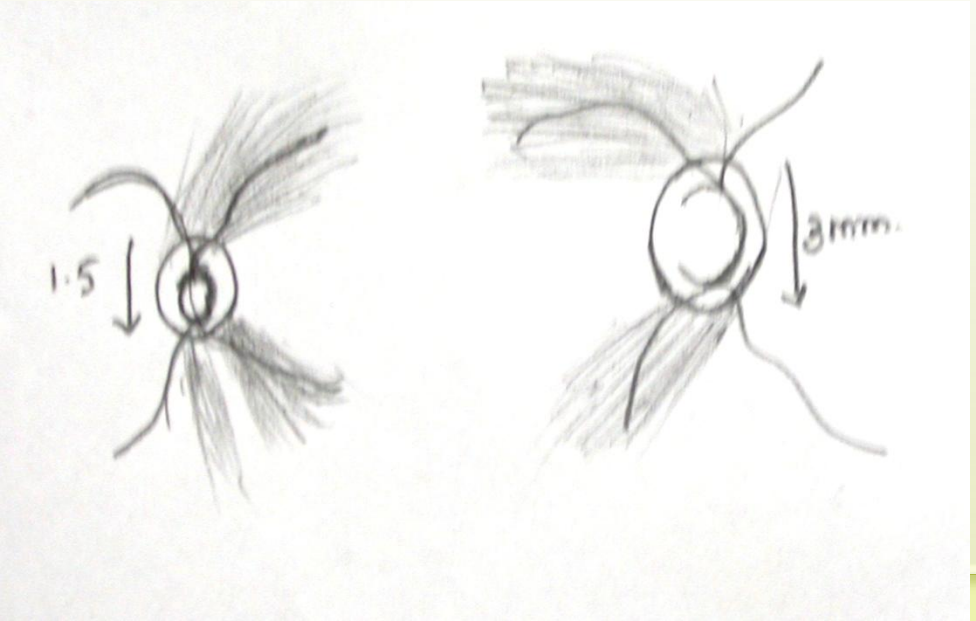
Optic Disc Photographs

Optic Disc Drawings



Documentation of disc damage:

- Monitoring change for progression
- Rate of change



Standard automated perimetry

- Important tool for glaucoma diagnosis and progression
- Measures visual function outside fovea within central 30 degrees of visual field defects in glaucoma occur within limits

Humphrey visual field analyser

- Popular perimeters in clinical use
- White on white perimetry
- One of the following test is usually used-30-2 full threshold, 30-2/24-2 SITA standard or 30-2/24-2 SITA Fast.
- SITA strategy takes less time than full threshold without loosing its diagnostic ability & is generally preferred.

Test selection

- Depends on status of the eye
- Patient's ability to perform the test
- In advanced cases where 24-2 or 30-2 pattern does not give enough information it is advisable to use a 10-2 pattern.
- Stick to same test pattern and thresholding algorithm for subsequent tests

Perimetry test parameters- Octopus vs HFA

Parameter	Octopus 300	HFA 700 series
Bowl type	Direct projection	Aspherical bowl
Background luminance	10 cd/m^2 (31.4 asb)	10 cd/m^2 (31.5 asb)
Stimulus size Stimulus duration Luminance for 0 dB	Goldmann III and V 100 ms 4800 asb	Goldmann I–V 200 ms 10,000 asb
Measuring range	0–40 dB	0–40 dB
Test strategies	4–2–1 dB bracketing strategy Dynamic Tendency oriented perimetry (TOP)	4–2 dB bracketing strategy SITA standard SITA fast

Fankhauser F *et al*. *Automated Perimetry: Visual Field Digest*. 5th Edn. Köniz: Haag-Streit AG, 2004.

Keypoints for perimetry

- Visual field examination is essential for diagnosis and management of glaucoma
- Must be done in all patients of glaucoma or suspected glaucoma
- It is important to have a good baseline in the beginning of the test. For this the test may have to be repeated 2-3 times or more at short intervals
- Test conditions should vary significantly from one examination to other

Keypoints for perimetry

- Field should be reliable. Unreliable fields should be ignored and test repeated.
- Built in software tools are useful and should be used to diagnose glaucoma and progression on visual fields
- Visual fields must be repeated periodically , frequency depending on severity and stability of glaucoma
- For glaucoma diagnosis visual field changes must correlate with clinical findings

Other recent tests for glaucoma diagnosis

Optical coherence tomography

- Can show each layer of tissue in the eye allowing to pinpoint the exact location of tissue damage.
- Aids in the diagnosis and management of glaucoma and macular degeneration.
- Safe, painless and quick procedure, does not require pupil dilation.
- A laser scans the retina, optic nerve, cornea, or anterior chamber in just a manner of seconds to provide a detailed information regarding the microscopic details of the eye.
- A glaucoma suspect would benefit from undergoing this diagnostic test.

http://www.washingtoneye.com/Chevy-Chase/glaucoma-screening-and-testing.htm. Last accessed 4th July 2014.

Heidelberg Retina Tomograph (HRT)

- Specialized lasers form a 3-D topographic map of the optic nerve and adjacent retina.
- A major advantage is that by taking a series of measurements over time, it can detect small changes that may otherwise go undetected by traditional methods of examination
- Since subtle changes in the optic nerve tissue can be the first sign of glaucoma and can precede visual field changes, the HRT may enable eye doctors to diagnose the disease earlier.

http://www.washingtoneye.com/Chevy-Chase/glaucoma-screening-and-testing.htm. Last accessed 4th July 2014.

Thank you