

Glaucoma is a progressive optic neuropathy characterised by retinal nerve fibre layer loss and ganglion cell death with associated characteristic visual field defects.

A clinical assessment for glaucoma involves: a glaucoma specific history, slit lamp examination, intraocular pressure (IOP) and central corneal thickness measurement, gonioscopy, optic nerve head assessment with image recording and visual field examination. Optical Coherence Tomography (OCT) measurement of retinal nerve fibre layer (RNFL) thickness may be the best among the currently available digital imaging instruments for detecting and tracking optic nerve damage in glaucoma (World Glaucoma Association statement).

Glaucoma Historical Risk Profile

The factors listed below have been associated with an increased risk of developing glaucoma.

- Family history (first-degree relatives)
- Advancing age (Caucasian and Asian descent over 50 and African descent aged over 40)
- Myopia (increased risk over -3DS)
- Ethnicity (African American POAG; East Asian PACG; Japanese NTG)
- 'Vascular related' factors:
 - Abnormal blood pressure (hyper and hypotension)
 - Migraines
 - Diabetes
 - Peripheral vasospasm
 - Sleep apnoea
- Previous ocular trauma
- Previous inflammatory anterior segment disease
- Steroid use (responders)
- Medications associated with angle closure (anticholinergic or sympathomimetic, tricyclic antidepressants, monoamine oxidase inhibitors, antihistamines, antiparkinsonian medications, antipsychotic medications, antispasmodic and sulphamates)

Gonioscopy

Gonioscopy allows the visualisation of the anterior chamber angle (Figure 1) and is crucial in excluding angle closure and causes of secondary glaucomas (see *types of glaucoma* below).

An occludable angle is typically defined as when the posterior (pigmented) trabecular meshwork is only visible for less than 90° of the angle circumference. Other factors such as peripheral anterior synechiae (PAS) however also need to be considered.¹

- Schwalbe's Line
- Anterior (non-pigmented) trabecular meshwork
- Posterior (pigmented) trabecular meshwork
- Scleral spur
- Ciliary body band

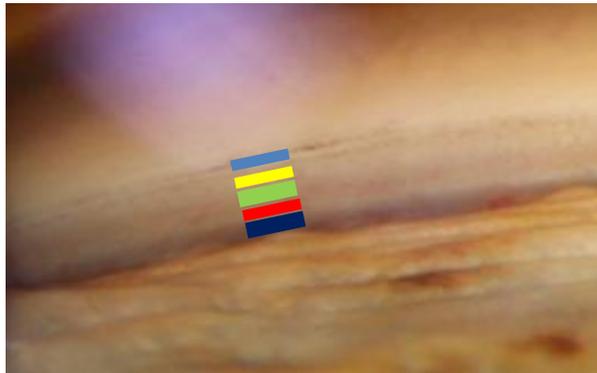


Figure 1. Gonioscopic image of the angle

Intraocular Pressure (IOP) and Central Corneal Thickness (CCT) ©CFEH

- Many variables can affect IOPs and IOP measurements, however the normal range of IOPs is typically defined as between 10 and 21mmHg
- Despite a number of limitations, applanation tonometry is considered the gold standard
- IOPs higher than 21mmHg increase the risk of glaucoma, however glaucoma is also commonly found in people with IOPs less than 21mmHg (normal tension glaucoma - NTG).
 - The incidence of NTG varies amongst population groups (most common in Japanese)

CCT needs to be considered in context with IOP assessment due to their inherent relationship, however corneal elasticity and other factors have also been shown to be influential in tonometric assessment of 'true' IOPs.

- An approximate normal range of CCT is ~545±35µm, however this can vary between ethnicities and instruments used (thinner in African-American and Japanese).²
- Thin CCT is theorised to be an independent risk factor based on the OHTS study results however this is still controversial.³

Anterior Eye and Slit Lamp Assessment

- Slit lamp examination is needed to assess the cornea, anterior chamber, iris and lens for potential causes of secondary glaucoma (see Figures 2-5 below)
- The incidence of secondary glaucomas varies markedly with patient demographics due to the nature of the underlying causative factors.

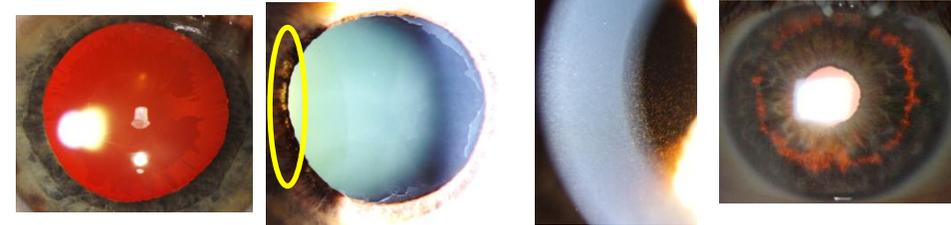


Figure 2.a) Pseudoexfoliative material on the anterior lens surface b) Peripupillary transillumination defects (Yellow circle)

Figure 3. a) Krukenberg Spindle observed in pigment dispersion b.) Transillumination defects in the mid-peripheral iris

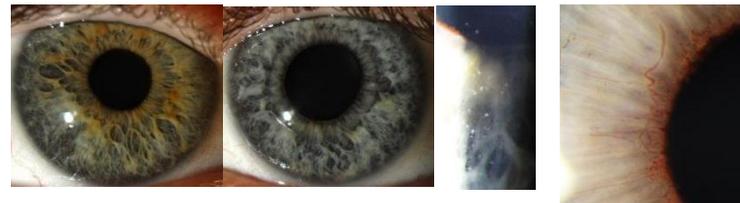


Figure 4. Heterochromia and keratic precipitates associated with Fuch's Uveitis Syndrome

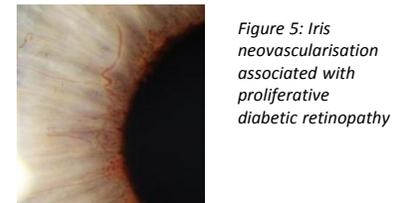


Figure 5: Iris neovascularisation associated with proliferative diabetic retinopathy



Chair-side Reference: Glaucoma Assessment



ONH and RNFL Assessment

Key factors to note in a glaucomatous disc assessment

- Size and orientation of the disc and cup
- Neuro retinal rim (NRR)
- Retinal nerve fibre layer (RNFL)
- Beta peripapillary atrophy (PPA)
- Drance haemorrhage
- Visibility / regularity of lamina pores

Changes that may be associated with glaucoma

- Thinning of the rim
- Development of a notch
 - Change in the position of the vessels
- Development of an acquired pit
- Development of, or increase in, an RNFL defect
- New disc haemorrhages
- Development of localised or diffuse pallor

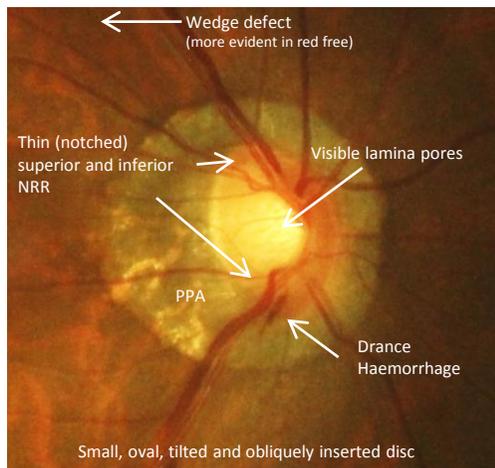


Figure 6. Glaucomatous Optic Nerve

Types of Glaucoma

Glaucoma can be classified into the following categories, some of which are associated with alterations in the conventional aqueous outflow process.

- **Primary open angle (POAG):** open angles, normal anterior chamber and elevated IOP
- **Normal tension:** a form of POAG with IOPs not exceeding 21mmHg (including phasing)
- **Primary and acute angle closure:** synechial or appositional closing of the angle
- **Pseudoexfoliation:** abnormal production of fibrillar proteins that are deposited in the angle
- **Pigment dispersion:** pigment released from the posterior pigmented iris epithelium deposited in the angle
- **Neovascular:** neovascularisation of the iris and angle secondary to ischaemia
- **Inflammatory:** ocular inflammation (acute and chronic uveitis) resulting in angle obstruction.
- **Lens related:**
 - Phacomorphic: an increase in lens thickness leading to angle closure
 - Ectopia Lentis: lens dislocation leading to angle changes or pupillary block
 - Phacolytic: protein release from a mature cataract or trauma
- **Traumatic:** alteration to the angle structure including ciliary body tear or angle recession
- **Phacomatoses:** can result in changes to the angle structures or aqueous outflow
 - Sturge-Weber
 - Neurofibromatosis type 1
 - Von-Hippel Lindau
 - Naevus of Ota
- **Tumour related:** obstruction of the angle by a growth (eg Iridociliary mass)
- **ICE Syndrome:** PAS and iris changes cause secondary angle closure, or closure of the angle due to change in the corneal endothelium.
- **Iridoschisis:** separation of the anterior stroma from the posterior stroma and iris layers causing secondary glaucoma.

Optical Coherence Tomography (OCT)

- OCTs have a variety of different methods of assessing the integrity of and detecting change in the Ganglion Cell and RNFL layers, including comparison of right and left as well as to a normative database.
- The strengths and limitations of the instruments and their analyses needs to be clearly understood when incorporating them into clinical analysis and decision making.
- Parameters that can be measured and analysed by OCTs include: Ganglion Cell (and associated layers) thickness (7a,b), RNFL thickness and distribution (7c,d,e), NRR / optic nerve head parameters and Bruch's membrane opening rim thickness.

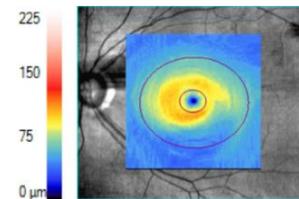


Figure 7. a) Ganglion Cell thickness map

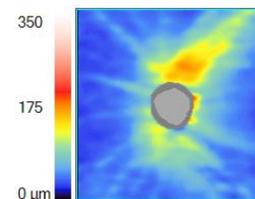


Figure 7 c) RNFL thickness map

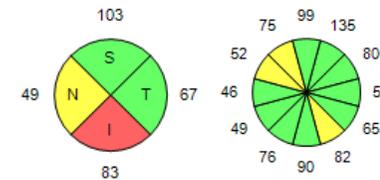


Figure 7 d) Quadrant and sector RNFL thickness measurements and normative comparison

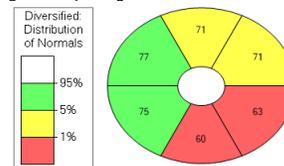


Figure 7. b) Ganglion cell sectoral thickness measurements and normative comparison

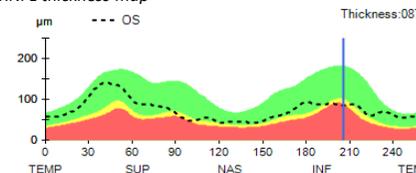


Figure 7. e) "TSNIT" RNFL thickness curve

Visual Field Assessment

Glaucoma is typically defined by characteristic disc changes associated with a correlating visual field defect. However, structural or functional loss can be detected in isolation depending on the sensitivity of the devices used.⁴

Visual field results need to be reliable, repeatable and affect a region consistent with glaucoma and any structural changes present.

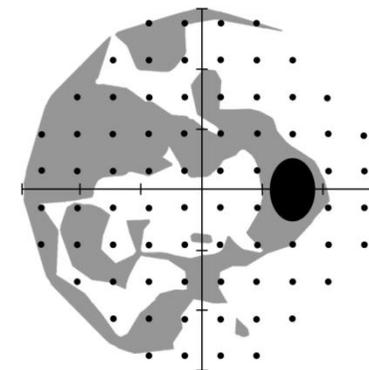


Figure 8: Regions most commonly affected in patients with glaucoma (adapted from Schiefer et al, IOVS, 2010)

References

1. Foster et al, *Br J Ophthalmol* 2004;88:486-490
2. Aghaian et al, *Ophthalmology* 2004;111(12):2211-9
3. Medeiros and Weinreb, *Ophthalmology* 2012;119(3):10
4. Keltner et al *Ophthalmology* 2006;113:1603-1612