General Optical Council Approved CET For Optometrists
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Glaucoma

Part 3 – Anterior segment examination in the glaucoma suspect

This third article in the series by **Dr Paul Spry** and **Dr Robert Harper** reviews anterior segment examination and gonioscopy, describing abnormal signs commonly associated with glaucoma.
Module C8873, two general CET points suitable for optometrists and dispensing opticians

Most of the glaucomas have intraocular pressure (IOP) as a major element in their causality. Because IOP is determined by physiological processes within the anterior segment, elevation of IOP may be associated with structural abnormalities within the anterior segment. These abnormalities can result from pathologies that have potential to cause glaucoma, and if found, demonstrate potential risk of glaucoma development. However, abnormal signs can also be due to the effect of glaucoma disease processes, thus providing valuable diagnostic clues.

The specific objectives of anterior segment examination in patients with, or at risk of glaucoma are:

1 Identification of signs that, alongside symptoms and history, inform differential diagnosis
2 Quantification of relevant risk factors associated with glaucoma development, such as IOP, drainage angle status and central corneal thickness (CCT)
3 Identification of co-existing pathologies, whether glaucoma-related or otherwise
4 Documentation of physical appearance, providing a baseline for future reference.

Examination components

Physical examination

A structured, systematic, physical examination maximises the likelihood abnormal signs associated with glaucoma risk or presence will be identified. Each anatomical structure that may contribute to raised IOP or glaucoma should be examined in turn, taking care to rule out the presence of all abnormal signs. Ideally, physical examination should begin simply by observing the patient and should then proceed to a slit lamp biomicroscopic exam.

Specialist techniques

Physical examination should be followed first by IOP measurement, CCT quantification (pachymetry) and then assessment of the anterior chamber drainage angle. IOP and CCT were covered earlier in this series and gonioscopy will be considered in this article.

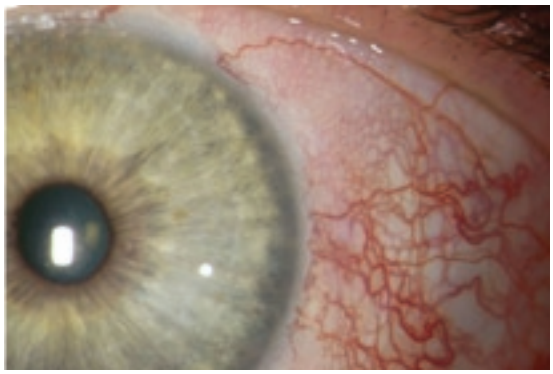


Figure 1 Dilated episcleral and conjunctival vessels

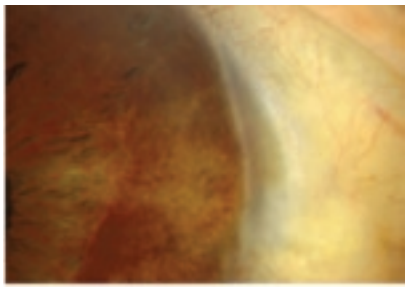


Figure 2 Posterior embryotoxon

Physical examination

Conjunctiva

Conjunctival abnormalities are best identified by direct and indirect slit-lamp illumination. Both bulbar and tarsal conjunctivae should be assessed. Abnormal conjunctival vasculature can imply both increased risk of glaucoma development or concurrent IOP elevation. Grossly dilated tortuous conjunctival and episcleral vessels (Figure 1) can result from raised episcleral venous pressure due to a variety of causes, including Sturge-Weber syndrome and arteriovenous malformations that may increase IOP by greater resistance to aqueous outflow. Conversely, deep pink circumlimbal flush is associated with acute substantial IOP elevation.

In addition, conjunctival allergic reactions can occur in patients taking topical anti-glaucoma medications. The usual signs of allergic conjunctivitis signs can result from sensitivity to any anti-glaucoma eyedrops. Patients using prostaglandin analogues may have mild bulbar hyperaemia due to the inflammatory pharmacologic mechanism causing vasodilatation, although may be disproportionately asymptomatic.

Cornea

The cornea is best examined using a variety of slit lamp illumination conditions, including direct, indirect, retro and parallelepiped. An initial examination should be performed at low magnification. The cornea can be impacted in a variety of ways by different glaucoma sub-types. A large number of abnormal corneal signs occur concomitantly with glaucoma disease processes. Others result from glaucoma and some rare corneal pathologies can cause glaucoma. While some of these are readily identifiable, others are more subtle.

Diameter

Corneal size asymmetries or diameter exceeding 12mm in the first year of life, or 13mm at any age suggests buphthalmos resulting from globe distension due to raised IOP in childhood and may indicate congenital glaucoma.

Appearance

Scarring

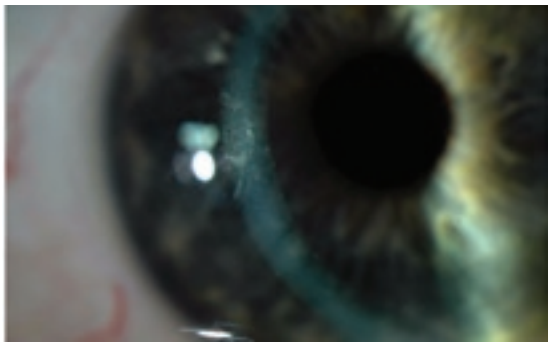
In general, observation of corneal scars suggest a history of trauma with associated damage to nearby structures, including anterior chamber (AC) angle damage, and therefore trauma should be asked about when this is observed. Furthermore, corneal scar tissue may impact on both thickness and biomechanics and should lead to informed interpretation of tonometric measurements.

Epithelium

Oedema may indicate concurrent acute or sub-acute IOP elevation.

Descemet's membrane

Infantile IOP elevation resulting in splits in this layer can remain visible



throughout life as characteristic double tracks ('Haab's striae') and are associated with congenital glaucoma.

Anterior termination of Descemet's membrane, referred to as posterior embryotoxon, is visible as a white line deep within the cornea, inside the limbus (Figure 2) and gonioscopically appears as an anteriorly positioned and thickened Schwalbe's line. Although present in ~8-15 per cent of most individuals, this finding can be associated with glaucoma secondary to abnormal anterior segment development (see below).

Figure 3 Grouped vesicles in posterior polymorphous dystrophy

Endothelial signs

In general, endothelial deposits are unlikely to represent normal physiology and are associated with conditions that increase the risk of glaucoma. Pigment in an hour-glass pattern, Kruckenberg's spindle, results from setting down of pigment where aqueous convection currents are slowest. Spindles occur in pseudoexfoliation and pigment dispersion syndromes, being greatest in the latter, and therefore suggest increased glaucoma risk.

Kruckenberg's spindles can be easily missed: high magnification examination of the corneal layers using retroillumination from the iris surface offers the best chance of detection. Care should be taken not to confuse this sign with minimal, non-spindle-shaped pigment deposition due to uncomplicated cataract extraction or with the pigmentation associated with cornea guttata, neither of which are associated with glaucoma development.

Keratic precipitates (KP) are less hard to spot and are associated with anterior uveitis. Any cause of anterior uveitis can elevate IOP and increase glaucoma risk. Small white and diffusely scattered stellate KP are common in glaucoma secondary to Fuch's heterochromic iridocyclitis. In addition, chronic IOP elevation can cause degenerative endothelial changes and PXF can have associated guttae-like endotheliopathy. It is also important to bear in mind that endothelial dystrophies have potential to impact corneal hydration and thickness and so can alter tonometric measurement validity.

Corneal causes of glaucoma

There are a number of rare, primary endothelial disorders that can lead to IOP elevation due to neighbouring AC angle involvement:

Iridocorneal endothelial (ICE) syndrome

This condition is a generally unilateral condition that tends to occur most commonly in women aged 30-50 years. Features of ICE syndrome include corneal oedema, 'beaten bronze' endothelial slit-lamp appearance due to variable cell size and regularity, iris changes, and peripheral anterior synechiae formation. This latter characteristic can result in a secondary angle closure and glaucoma that is refractory to treatment. ICE syndrome is thought to constitute an abnormal growth of corneal endothelium throughout the AC, and can take three main forms, depending on the tissues affected. ICE syndrome therefore varies from

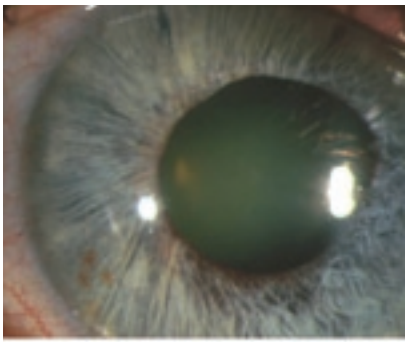


Figure 4 Damaged iris stroma

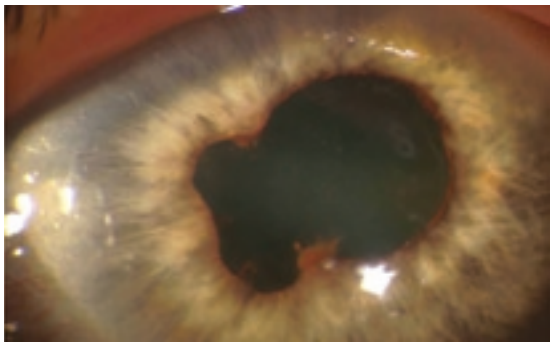


Figure 5 Posterior synechiae

corneal changes and mild iris atrophy (Chandler's syndrome), through to extreme iris atrophy with polycoria and corectopia (essential iris atrophy), to development of naevus-like pigmented nodules on the iris surface (Cogan-Reese syndrome).

Posterior polymorphous dystrophy (PPMD)

This condition can cause raised IOP due to membranous endothelial overgrowth on AC angle tissue. This condition is rare and usually bilateral. Clinically, the endothelium in PPMD contains vesicles, which may be linear or grouped (Figure 3). Estimates of glaucoma prevalence in PPMD approximate 15 per cent.

Anterior chamber

The normal AC is optically empty, being filled with aqueous. AC activity represents an abnormal sign that can negatively impact of aqueous outflow.

Cells

AC cells can cause increased aqueous viscosity and physical clogging of the trabeculum, reducing aqueous outflow, and causing IOP elevation. Unless numerous, cells suspended in the aqueous are easy overlooked, being best seen using direct slit-lamp illumination with a bright thin beam, short, obliquely orientated and focused midway between the corneal endothelium and iris. Cells are most easily spotted by looking directly in front of the pupil to enhance contrast, where they may appear like dust particles in a cinema projector beam. Being heavier than aqueous molecules, cells usually fall into the inferior angle. Instructing patients to make eye movements can 'stir up' the aqueous, making cells easier to spot.

Three cell types of cell can be found within the AC. White blood cells appear as small reflective specks and indicate inflammation, which may be associated with uveitic or phacolytic glaucoma. Red blood cells (RBCs) usually occur in larger numbers and form a hyphaema. Because RBCs can exit the AC via the trabecular meshwork, they tend to cause no more than a transient IOP elevation, although are clinically significant because they indicate that trauma has occurred, raising the possibility of AC angle damage. The final cell type, ghost cells, are RBCs in which the haemogoblin has degraded, making the cells inflexible and unable to exit the AC via the trabecular meshwork. Ghost cells usually result from long-standing vitreous haemorrhage that has leaked into the AC via a damaged anterior hyaloid face.

Flare

This sign represents aqueous-suspended protein and is best seen with low ambient lighting, having the appearance of car headlamp beams in fog. Severe flare can mask iris details. The most commonly cause is blood-aqueous barrier breakdown in anterior uveitis, indicating the possibility of inflammatory glaucoma. Flare can also occur due to leaked lens protein in phacolytic glaucoma.

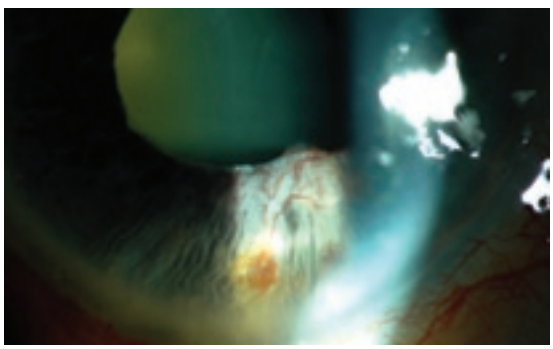
Miscellaneous debris

Pigment granules liberated by pupil movement in PDS may be visualised in a manner similar to inflammatory cells, particularly after pharmacologic dilation or patient exercise. Trauma to the lens capsule can lead to the presence of large lens fragments in the AC with a risk of lens particle glaucoma.

Iris

The majority of iris abnormalities associated with glaucoma either occur concomitantly with pathophysiologic processes that can lead to glaucoma (eg PDS, PXF) or result from IOP elevation.

Figure 6 Rubeosis iridis



Atrophy

Iris atrophy occurs due to ischemia, and therefore is encountered in glaucomas with IOP elevation sufficient to damage tissue structure and pigmentation. Atrophic areas typically appear grey due to loss of stromal pigment. Damaged stromal tissue may appear debulked, with atrophic stromal fibres appearing spiralled or whorled (Figure 4). Iris transillumination results from atrophy sufficient to impact pigment epithelium on the posterior iris surface.

- Diffuse atrophy is likely to be the result of intermittent, repeated IOP elevations, occurring commonly in Fuch's heterochromic iridocyclitis, with the affected iris being paler in colour due to depigmentation, although may also be seen in inflammatory glaucoma caused by other types of uveitis. Mild atrophy associated with some loss of colour may occur in PXF.
- Focal/sectoral iris atrophy is more likely to be the result of a single episode of substantial IOP elevation and will affect pupil shape or position if iris musculature is affected.
- Severe atrophy is most likely to result from glaucoma sub-types with associated prolonged periods of substantial IOP elevation eg chronic primary angle closure.

Iris surface deposits

Pigment granules dispersed from the pigmented epithelium can be set down on the anterior iris surface, taking on an irregular concentric ring appearance with dilation and constriction. This change is most common in PDS but may also be observed in PXF.

Pupil

- Margin. Damage to iris pigment epithelium in PXF may sometimes be observed as pigmentary collarette discontinuity. PXF material on the iris at the pupil margin, with translucent blue-green flakes reminiscent of dandruff is a classic, diagnostic sign.
- Dimensions. Ischemic and traumatic damage to sphincter and dilator pupillae muscles can affect pupil shape, size, symmetry and reactivity. Also, existing use of pilocarpine will result in an unresponsive miotic pupil. Severe pupil distortion can occur with posterior synechiae (Figure 5) and provides evidence of current or past inflammation. Often, synechiael tethering of the ▶

posterior iris surface to the adjacent anterior capsule cannot be visualised until pharmacologic dilation is attempted.

Transillumination defects

Retroillumination of the iris using an intense, short and narrow slit-lamp beam will help identify depigmented areas of the posterior surface epithelium, referred to as transillumination defects. Mid-peripheral spoke-like radial transillumination defects are pathnomonic of PDS resulting from mechanical rubbing of the iris epithelium against the lens zonules.

Neovascularisation

Abnormal new iris blood vessels ('rubeosis') usually first occur around the pupil margin and appear as focal dilations of existing capillaries or juxtapupillary random iris surface vessels (Figure 6). Rubeosis results from angiogenic factors of any origin eg retinal hypoxia or intraocular tumours. Diabetic retinopathy and retinal vascular occlusions are the commonest causes of neovascular glaucoma, accounting for ≈50 per cent of cases. Presence of new vessels with associated fibrovascular tissue in the open angle initially obstructs the open AC angle, but with time membrane contraction pulls the iris forward, causing peripheral anterior synechaie and secondary angle closure.

The iris as a cause of glaucoma

Excepting iris involvement in PDS, primary iris abnormalities sufficient to cause glaucoma are rare. The most frequent iris abnormality that increases glaucoma risk is plateau iris, an abnormal iris anatomic configuration in which the iris plane is flat and central AC of normal depth but with a closed or occludable angle. This configuration may contribute to primary angle closure. Rarer abnormalities include iridoschisis and iris cysts, both of which have the potential to cause secondary angle closure.

Developmental disorders of the anterior segment

Axenfeld-Rieger syndome

This family of three disorders increases in severity from Axenfeld's anomaly, in which multiple peripheral iris strands (iris processes) adhere through variable angular subtense to a posterior embryotoxon, through Reiger's anomaly, in which there are additional iris changes including areas of atrophy, with possible polycoria (multiple pupils) and correctopia (displaced pupil). The most severe form is Rieger's syndrome, in which the ocular abnormalities have systemic associations, including dental abnormalities (small-crowned or absent teeth), facial anomalies (flattening of the midface and receding upper lip and telecanthus (wide interpupillary distance). Angle changes in these individuals can negatively impact on angle physiology and glaucoma has been reported to develop in up to 50 per cent of individuals with variants of the syndrome.

TABLE 1

Van Herick grade	Cornea: Aqueous interval	Angle closure
4	1: ≥0.50	Unlikely
3	1: ≥0.25 to 0.50	Unlikely
2	1: 0.25	Capable
1	1: <0.25	Likely
Slit-like	Little gap seen	Imminent
0	No gap seen	Closed

Aniridia

Although the iris is absent on slit-lamp examination, many patients with aniridia have a small stump of gonioscopically visible residual iris. Contraction of this residual tissue over the AC angle with time causes glaucoma. Glaucoma prevalence in aniridia is about 50 per cent.

Peter's anomaly

The anomaly, present at birth, is a rare and usually bilateral central defect in Descemet's membrane and the corneal endothelium, with associated overlying corneal scarring and iridocorneal adhesions surrounding the central corneal defect. Some affected individuals also have keratolenticular contact and/or peripheral iridocorneal adhesions. Approximately one half of patients with Peter's anomaly develop glaucoma, believed to result from involvement of the trabecular meshwork.

Lens

Examination is best performed through a dilated pupil in order to examine a substantial proportion of the lens. Direct, indirect and retro illumination methods should be employed. The lens can exhibit a number of signs resulting from pathologic processes that can also lead to glaucoma. These signs include the following:

Abnormal anterior surface appearance

It is often possible to visualise PXF material on the anterior capsule surface before identifying it elsewhere. This material is mechanically rubbed away by adjacent iris movements in paraxial areas, leaving an annulus of central denuded capsule, bordered by central and peripheral material-covered zones.

Anterior subcapsular lens opacities

Presence of 'glaukomflecken' indicate the possibility of a previous period of acute and substantial IOP elevation. These opacities are irregular, and are located immediately behind the capsule and correspond to areas of damaged lens epithelium.

Zonular signs

- Phacodonesis. Weakness of the lens' suspensory ligaments is associated with PXF syndrome. Clinically, this can sometimes be seen as temporal perturbations of the iris surface with small eye movements.
- Pigmentation. In PDS, pigment granules can accumulate behind the lens between the posterior capsule and zonules, referred to as 'Scheie's sign'. Due to the peripheral location, this can usually only be seen through a dilated pupil.

The lens as a cause of glaucoma

Cataract

- Phacolytic (lens protein) glaucoma. Hypermature cataracts can release high molecular weight soluble lens proteins through lens capsule defects. These can block the TM directly, or increase macrophage size, such that they cannot exit via the TM, therefore reducing aqueous outflow by physical obstruction.
- Phacomorphic glaucoma. Mature cataracts can swell and reduce both peripheral and central AC depth, causing secondary angle closure.
- Lens particle glaucoma. Damage to the capsule in trauma or cataract extraction can release large and irregular translucent white particles of aggregated lens fibres into the anterior chamber, which can incite inflammation and cause angle obstruction.

Pseudophakia

Damage to anterior segment structures during complicated cataract extractions can negatively impact on anterior segment physiology and lead to IOP elevation, both acutely (eg due to post-operative inflammation) and/or chronically (eg due to angle distortion and/or damage). It is therefore important to note signs associated with complex cataract extraction, such as implant lens malposition, iris damage, iris entrapment behind the implant and pupil shape irregularity.

Lens dislocation

Complete and incomplete (subluxation) lens dislocation (Figure 7) can cause glaucoma by pupil block with forward movement, and may also lead to phacolytic glaucoma.

Quantitative assessment of the anterior chamber

Determination of the AC dimensions in order to assess the proximity of angle structures is an essential element of glaucoma patient or suspect assessment. Total internal reflection within the cornea dictates that gonioscopy is the only slit-lamp based method of angle visualisation and therefore is the method of choice. If gonioscopy cannot be performed, grading of the peripheral chamber depth becomes integral to examination. Supplementary quantification of central AC depth provides an indication of risk of pupil block, because of the association between a shallower central AC and the degree of iridolenticular contact.

Peripheral anterior chamber assessment by Van Herick technique

This technique should be performed for both nasal and temporal aspects of the cornea by positioning the observation system directly in front of the patient and the illumination system at 60º. With the patient looking directly ahead, a thin slit beam should be moved from the sclera across the limbus until a corneal section is just visualised (Figure 8). The ratio of cornea to anterior chamber (ie aqueous gap) should be graded at this point. The grading system and interpretation is given in Table 1. A small proportion of patients will be unsuitable for Van Herick technique assessment due to obscuration of the view of peripheral cornea.

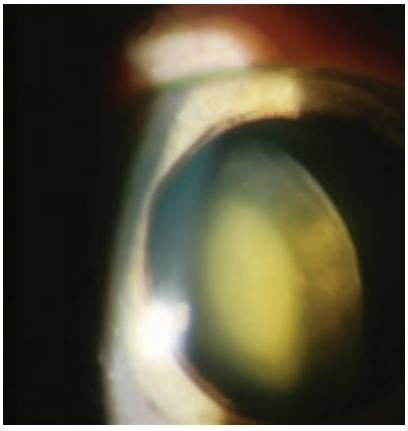
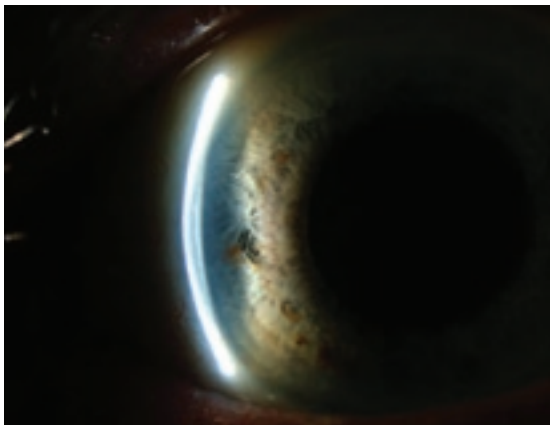
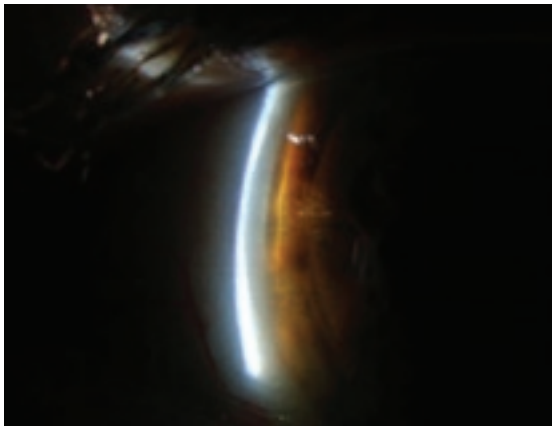


Figure 7 Lens subluxation





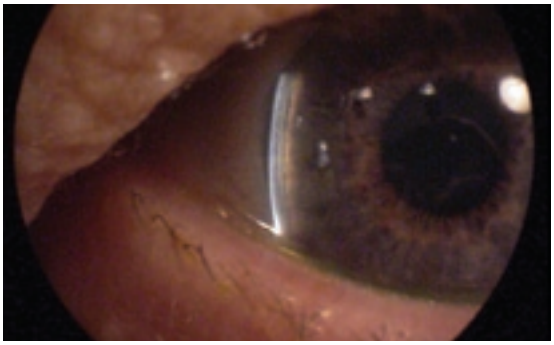


Figure 8 Van Herick technique

Measurement of central anterior chamber depth by Redmond Smith technique

This technique is illustrated in Figure 9 and can be performed as follows:

- The slit lamp should be set up with the viewing system positioned directly ahead of the patient and illumination system set temporally at 60º, with a horizontally-orientated moderately thick slit-beam. The patient should be asked to fix their gaze on the microscope.
- The horizontal slit-beam should be focused onto the cornea. The reflections from both cornea (focused temporal reflection) and iris-lens (defocused nasal reflection) should be observed and the beam length ('height') adjusted until the tips of their reflections just touch.
- Once touching, the slit height should be read off from slit lamp and multiplied by 1.4 to obtain an estimated of the central AC depth in millimetres (mm).

Smith considered that AC depths of 2mm or less should be 'regarded with considerable anxiety, especially if mydriasis is contemplated'.

Gonioscopy

Gonioscopy is the clinical examination technique of the iridocorneal angle structures. Its purpose is threefold:

- To assess the proximity of angle structures
- To determine angle topography
- To identify abnormal angle features.

Performing gonioscopy

Lens choice

Indirect goniolenses only (Figure 10) will be considered in this article because of their ease of use at the slit lamp. They fall into two categories according to their ocular contact area.

- *Scleral lenses*. Typically with diameters of 15 or 18mm, these lenses are more concave that the cornea is convex and therefore require coupling fluid. Their main advantages include provision of an excellent quality image of angle structures, generally reasonable level of image magnification and, because of the lens-corneal apex distance, are unlikely to alter angle topography. As such, they are the lens of choice for many clinicians. Available lenses vary from one mirror designs (eg Goldmann one mirror) that provide a view of one quadrant of the angle at any one time and have to be rotated to visualise the angles entirety, to four mirror types (eg Thorpe lens).
- *Corneal lenses*. Corneal lenses have a contact diameter less than corneal diameter, typically 9mm. They are less concave that the cornea is convex and do not require a coupling fluid. These lenses are advantageous because they permit rapid angle assessment and also permit corneal indentation when the user wishes to differentiate between appositional and synechiael angle closure. The major disadvantage is that inadvertent indentation can occur, artifactually opening the angle. Also magnification

with corneal lenses is lower than scleral lens types. Corneal lenses are available with (eg Sussman, G4) and without handle mounts (eg Posner).

Examination conditions

Gonioscopy should be performed in conditions in which the angle is likely to be at its physiologically narrowest, ie dark room and low slit lamp beam height such that light does not enter pupil. Initial examination is best performed with low slit lamp magnification (X10), with co-axial illumination and viewing.

Angle structures

Gonioscopy relies upon the ability of the examiner to identify the angle's gross anatomic features. Figure 11 is the annotated gonioscopic view of a normal angle, identifying each angle structure, as follows:

Schwalbe's line (SL)

SL is the most anterior angle structure. As the posterior termination of Descemet's layer, SL represents the transition between corneal endothelium and anterior TM. Gonioscopically, it is visible as a thin, opaque white line that can sometimes be hard to identify, in which case identification of the 'corneal wedge' may be useful. A change in surface gradient occurs at SL, between the steep posterior cornea and the more gently sloping angle. Pigment granules therefore have a tendency to a collect here, and may form a Sampaolesi's line in PXF and PDS.

Trabecular meshwork (TM)

TM tissue occupies the substantial majority of normal angle volume, filling the area between the adjacent SL anteriorly and the scleral spur posteriorly. Anatomically, TM consists of three layers with increasing trabecular beam density, from the uveal layer closet to the aqueous, through the intermediate corneoscleral layer, to the juxtacanalicular layer bordering the endothelium of Schlemm's canal. The normal TM varies in appearance from apigmented to densely pigmented in eyes with general abundant pigmentation. Apigmented angles can appear entirely featureless, with the TM obvious only as a grey band between the SL and the ciliary body. In general, TM pigmentation increases throughout life, with the functional TM becoming more pigmented than the anterior non-functional areas. Gonioscopically, TM consists of two regions, (i) the anterior, non-functional region; and (ii) the posterior functional region, leading to Schlemm's canal,

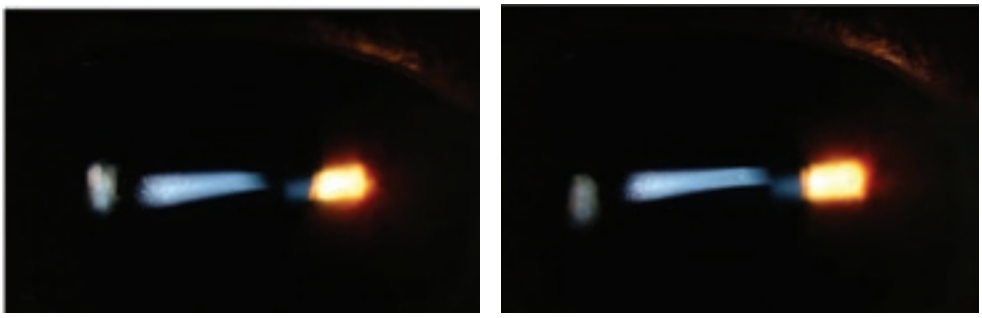


Figure 9 Smith's technique

TABLE 2

Grade	Angle width	Most posterior structure visible	Status
4	35-45°	Ciliary body band	Incapable of closure
3	20-35°	Scleral spur	Incapable of closure
2	20°	Trabeculum	Narrow angle; closure possible but unlikely
1	≤10°	Schwalbe's line, with top of trabeculum	Very narrow angle; closure probable but not inevitable
Slit	Slit	No angle structures visible (no obvious iridocorneal contact)	Danger of imminent closure
0	0°	No angle structures visible (iridocorneal contact present)	Closed

Figure 10 Indirect goniolens

with this latter region usually being more pigmented.

Schlemm's canal (SC)

Lying within the angle behind the juxtacanalicular TM, this structure is not visible in most normal eyes. Infrequently, excess pressure on the episcleral venous system during gonioscopy with large diameter scleral lenses can produce backflow of blood into SC producing the appearance of a broad pink band within the posterior pigmented TM.

Scleral spur (SS)

The SS is the most anterior portion of sclera and is the posterior boundary of the TM. Gonioscopically, SS has the appearance of a pale to light grey band. Although SS can usually to differentiated from all but the least pigmented TM, it is easy to distinguish from the posteriorly adjacent ciliary body.

Ciliary body band (CBB)

The width of this band depends on the exact position of insertion of the iris root. Generally, insertion of the iris into the concave ciliary body face leads to presence of a band of gonioscopically-visible ciliary body tissue, forming the CBB. This is variably pigmented, varying from pinky-grey to dark grey or brown in appearance. CBB width varies in proportion to eye size, being wide in myopia and narrow in hypermetropia.

Iris

The iris surface is the most posterior visible gonioscopic landmark and physiologically inserts into the ciliary body, either posterior to, or occasionally level, with the SS. Rarely, iris insertion anterior to the SS can occur. Normal peripheral iris contour is usually slightly convex.

Angle feature differences in normal and pathological angles

Deposited materials

● *Pigment*. Normal angle pigmentation tends to be regular and greater inferiorly. Although there are no discriminators ▶

MULTIPLE-CHOICE QUESTIONS – take part at www.opticianonline.net

1 In the context of glaucoma, which of the following are grossly dilated tortuous conjunctival and episcleral vessels most likely to indicate?
A Acute substantial IOP elevation
B Reaction to prostaglandin analogue medication
C Raised episcleral venous pressure
D Pigment dispersion syndrome

2 Which of the following statements about corneal diameter is true?
A Diameter below 12mm is suggestive of buphthalmous in a neonate
B Diameter above 13mm is suggestive of buphthalmous in an infant aged six months
C Diameter above 12mm is abnormal in a two-year-old
D Diameter above 12mm is normal in an infant aged six months

3 Which of the following statements is incorrect?
A Corneal epithelial dystrophies indicate uveitic glaucoma
B Kruckenberg's spindle results from setting down of pigment where aqueous convection currents are lowest
C Corneal endothelial deposits are unlikely to represent normal physiology
D Chronic IOP elevation can cause degenerative endothelial changes

4 Which of the following features is least likely to be observed in ICE syndrome?
A Angle closure
B Iris atrophy
C Pigmented nodules on the iris surface
D Keratolenticular contact

5 Which of the following statements is untrue?
A Mid-peripheral spoke-like transillumination defects are pathnomonic of pigment dispersion syndrome
B Ghost cells are red blood cells within which the haemoglobin has degraded
C White blood cells in the AC can indicate uveitic glaucoma
D AC flare is due to presence of suspended red blood cells

6 Which of the following abnormal crystalline lens signs is associated with pseudoexfoliation syndrome?
A Glaucomflecken
B Scheie's sign
C Phacodonesis
D Posterior subcapsular cataract

7 Which of the following statements is incorrect?
A Axenfeld's anomaly has ocular and systemic signs
B Reiger's anomaly can cause polycoria
C Peter's anomaly is a bilateral central Descemet's membrane defect
D Lens particle glaucoma can result from a damaged anterior capsule

8 In respect of the Redmond-Smith method of AC depth measurement, which statement is incorrect?
A The technique provides an estimate of central AC depth
B The depth or gap between a vertical slit-lamp beam on the cornea and that on the iris/lens plane is graded when viewing at an angle of 60 degrees
C At the measurement end-point, the final slit-lamp height reading needs to be multiplied by 1.4 to obtain the estimate of AC depth in mm
D According to Redmond-Smith, caution should be exercised when considering dilation for depths <2mm

9 In relation to indirect gonioscopy lenses for use at the slit-lamp, which of the following is correct?
A Corneal lenses (such as the Sussman) require a coupling fluid between the lens and cornea
B Scleral lenses permit indentation gonioscopy and can help differentiate appositional and synechial angle closure
C Scleral lenses are available in different designs of one to four mirror types
D Corneal lenses must be used with a handle mount

10 Which of the following statements about angle structures and gonioscopy is incorrect?
A The anterior trabecular meshwork is usually more pigmented than the posterior trabecular meshwork
B Schwalbe's line may be visible gonioscopically as an anteriorly placed, thin, opaque white line
C The ciliary body band width depends upon the position of insertion of the iris root
D Blood in Schlemm's canal can be seen in normal eyes if excess pressure is applied during gonioscopy

11 Which of the following features cannot be regarded as a variation of normal?
A Pigment, especially in the inferior angle
B Small regular radial vessels based at the iris root
C Iris processes
D Angle recession

12 In respect of angle grading systems, which of the following statements is correct?
A The Shaffer system permits qualitative assessment of the iris insertion point and profile
B The Spaeth system is widely implemented on account of simplicity
C The Shaffer system permits estimation of the angular subtense on the basis of visible angle structures
D Grade IV (4) in the Shaffer system indicates that the posterior TM is visible and that angle closure is likely

The deadline for responses is May 15

between pigmentation of physiological and pathological states, pigment present in abnormal angles tends to be characterised by either irregularity (eg heavy pigment patches, Sampaolesi line), or magnitude, such as the dense pigment aggregations associated with pathological release of pigmentation throughout the anterior segment.

● *Pseudoexfoliation*. Rarely, large aggregations of PXF material can be visualised in the angle, usually inferiorly.

Vasculature

Visualisation of normal blood vessels in the angle is relatively uncommon. Physiological vasculature comprises sections of the circumferential major arterial circle, and/or small regular radial vessels situated around the iris root or CBB. When present, rubeotic vessels tend to be fine, arborising and disorganised. Unlike physiological vessels, they may cross the scleral spur. ▶

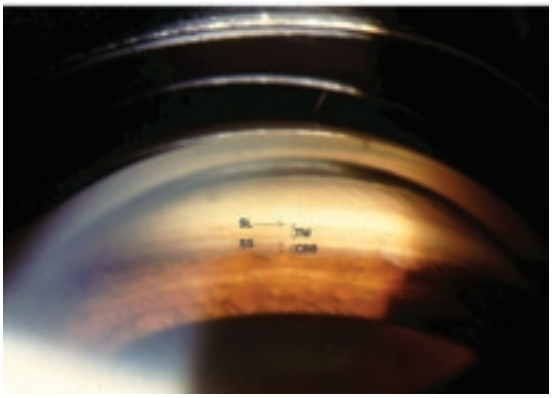


Figure 11 The annotated gonioscopic view of a normal angle

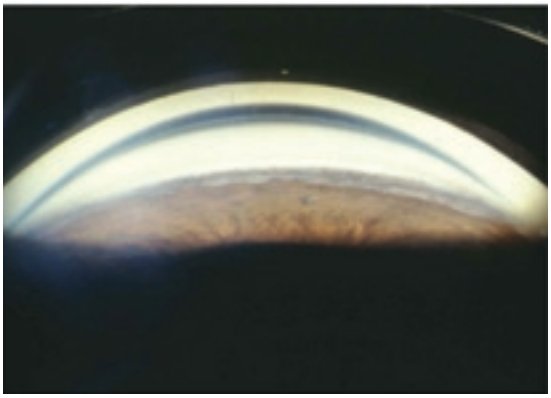


Figure 12 Blunt globe trauma causes the CBB to appear wide

Iris-angle encroachment

Physiological extensions of the iris reaching into the angle are called iris processes. These are common congenital formations representing extensions of the peripheral iris across the TM, sometimes reaching as far forward as SL. They are usually thin and delicate in appearance, have pigment matched to the iris stroma, and follow the angle's surface contour. Pathological, acquired adhesions between the iris and angle or cornea are called peripheral anterior synechaie (PAS), appearing as thick, opaque tissue bands that bridge the angle, tethering and distorting the adjacent iris from which they emerge, giving a tented appearance.

Angle recession

Blunt globe trauma produces tangential force that can shear angle structures at the level of the CBB, causing it to appear uncharacteristically wide (Figure 12). This finding is usually in association with a deep AC, and sometimes a scooped-out angle appearance. Angle recession does not usually affect 360° allowing normal and recessed areas to be differentiated.

Grading the anterior chamber angle systems

At present, the most popular grading system employed by clinicians in the hospital environments is a modified version of that originally described by Shaffer, as shown in Table 2. This system estimates the angular subtense on the basis of the visible angle structures. The advantages of this system are that it is easy to use, interpret and is widely used. However, a disadvantage is that the system fails to characterise other important qualitative aspects of the angle, such as iris insertion point, profile of peripheral iris, degree of angle pigmentation. Alternative, more detailed systems have therefore been proposed that provide greater angle detail eg Spaeth, Prokopich-Flangan, although these are beyond the scope of this article.

Further reading

1 Van Herick W, Shaffer RN, Schwartz A. Estimation of width of angle of anterior chamber. Incidence and significance of the narrow angle. *Am J Ophthalmol*, 1969; 68(4): 626-9.

2 Smith RJH. A new method of estimating the depth of the anterior chamber. *Br J Ophthalmol*, 1979; 63: 215-220.

3 Prokopich CL, Flanagan JG. Evaluation of the anterior chamber angle. In, *Glaucoma Identification and co-management*. Editors Edgar D, Rudnicka A. Butterworth Heinemann Elsevier, Edinburgh, 2007.

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