Chapter 4

Evaluation of the anterior chamber angle

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CHAPTER CONTENTS

4.1 INTRODUCTION

Evaluation of the anterior chamber angle is an essential component in the clinical assessment of the glaucoma patient or suspect. This chapter will consist of an outline of the relevant clinical techniques, concentrating mainly on gonioscopy, along with a guide to interpretation of the findings. The congenital and developmental glaucomas will not be considered as they would not normally be included within a co-management arrangement or be managed by a primary eye care clinician.

Gonioscopy refers to the technique used to view and define the structures and abnormalities of the anterior chamber or iridocorneal angle.[1–6] Improvements to gonioscopic lenses and techniques have made the procedure accessible and more feasible in the primary eye care examination. Detection of narrow angles by the van Herick method (Table 4.1) is one of the indications for evaluating a patient's angles to determine the risk for spontaneous and pharmacologically induced angle closure.[7] All patients determined to be at risk for primary or secondary open or closed angle glaucoma should have gonioscopy performed to identify further risk factors, and to differentiate the disease aetiology and decide the most appropriate therapeutic approach (Table 4.2). Gonioscopy should also be performed periodically on every chronic glaucoma patient to monitor detectable changes to the drainage structures.

Gonioscopy is contraindicated following acute trauma especially in the presence of hyphaema or

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Table 4.1 van Herick slit lamp angle grading system

Grade	Comparison of corneal section width to shadow formed in angle	Likelihood of primary (pupillary block) angle closure (with or without mydriatic agents)
4	1:1 or 1:>1	Not likely
3	1:1/4 to 1:1/2*	Not likely
2	1:1/4	Angle is considered capable of angle closure
1	1:<1/4	Angle closure likely
Slit-like	Very little shadow seen	Angle closure imminent
Closed†	No shadow seen	Angle is closed

* Angles wider than 1:1/2 but less than 1:1 may be designated Grade 3+, or Grade 4–.
† Note that eyes with arcus should not necessarily be interpreted as closed if no shadow is seen.

Table 4.2 Indications for gonioscopy in glaucoma[3,4,6]

Type	Indications	Specific indications Primary glaucomas
Open angle	All glaucoma patients	Gonioscopy is essential to determine the mechanism of glaucoma, e.g. primary vs. type of secondary *Primary open angle glaucoma is a diagnosis of exclusion*
	All glaucoma suspect patients	Elevated intraocular pressure (IOP) (>21 mmHg) IOP asymmetry of ≥3 mmHg Suspicious optic nerve head appearance and/or asymmetry of the optic disc cups Multifactorial risk factors: e.g. suspicious visual field defects, positive family history, vasospastic disease and anaemias, nutritional abnormalities, myopia, diabetes, race, age
Closed angle	Narrow angle and shallow anterior chamber	van Herick grade 2 angle assessment or narrower Other anatomical features often associated with the narrow angle, e.g. hyperopia, short axial length, shallow anterior chamber, small corneal diameter, steep corneal curvature, thicker crystalline lens, anterior lens position
	Suspicion of plateau iris configuration	Narrow angle by van Herick but deep anterior chamber
	Mild forms of angle closure: intermittent and sub-acute	Brief relative pupillary block episodes that resolve spontaneously (often lead to an acute attack) Uniocular dull ache, mild blurry vision, rarely haloes, recurrences at same time of day or following near work Symptoms often reported to be relieved by sleep
	Chronic and creeping angle closure	Uncommon in Caucasians, common in Asians, tends to occur in Afro-Caribbeans who develop angle closure Asymptomatic repeated attacks cause portions of the angle to be permanently closed by peripheral anterior synechiae Often lead to an acute attack

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Table 4.2 Continued

Type	Indications	Specific indications Primary glaucomas
	Acute angle closure	Precipitating events include illness, emotional stress, trauma, intense concentration, pupillary dilation (pharmacological or physiological) Blurred vision, haloes, intense pain, ciliary injection, lid oedema, tearing, anxiety, fatigue, nausea, mid-dilated/vertically oval pupil
Type	**Indications**	**Specific indications Secondary glaucomas**
Open angle		Pigment dispersion (PDS): endothelial pigment deposition (often Krukenberg spindle), iris transillumination defects, heavy pigment deposition in angle Pseudoexfoliation syndrome (PEX): flaky debris noted on iris frill and in bulls eye pattern (visible on lens once pupil is dilated), pigment clumping in angle Iridocorneal endothelial syndromes (ICE syndromes): down growth of endothelial cells over trabeculum, polycoria or irregular pupil (usually unilateral) with or without monocular diplopia Corticosteroid induced from chronic use of topical steroid drops Recurrent or chronic inflammation (anterior uveitis): cells in anterior chamber with or without flare, including Fuchs iridocyclitis, glaucomatocyclitic crisis (Posner–Schlossmann syndrome), phakolytic and systemic disease associated uveitis Non-acute history of ocular trauma: concern of angle recession, cyclodialysis, suspicion of intraocular foreign body Blood-induced post surgery or trauma, e.g. ghost cell, haemolytic, hemosiderotic glaucoma Elevated episcleral venous pressure: venous obstruction (e.g. thyroid ophthalmopathy), or arteriovenous anomaly (e.g. carotid cavernous sinus fistula) Drug-induced: some drugs have been shown to increase IOP (uncommon)
Closed angle	Anterior mechanism: angle is *pulled* closed	Risk of rubeosis iridis and neovascular glaucoma (NVG secondary to ischaemic retinal disease), iridocorneal endothelial syndromes (ICE), posterior polymorphous dystrophy Risk of peripheral anterior synechiae following trauma and/or inflammation (anterior uveitis)
	Posterior mechanism: angle is *pushed* closed	Lens related: thickened intumescent lens, forward subluxation Iris and ciliary body cysts or tumours Pseudophakic pupillary block Malignant glaucoma Retina–choroid related: choroidal effusion (e.g. following panretinal photocoagulation, scleral buckling, intravitreal gas injection or silicone, pars plana vitrectomy, and has been reported in AIDS)
	Uncommon causes	Certain drugs (e.g. psychotropics, antidepressants, antihistamines, antiparkinsonian agents, autonomic agents) that cause pupillary dilation may precipitate chronic angle closure in susceptible individuals Intraocular tumours: uveal melanomas, metastatic tumours, retinoblastoma, phakomatoses Retinal related: e.g. central retinal vein occlusion (rare)

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microhyphaema. Seidel's test is indicated when an intraocular foreign body is suspected and B-scan ultrasonography or X-ray should also be considered to rule out foreign body penetration. Similarly, gonioscopy is not recommended immediately post-cataract surgery or following other penetrating intraocular surgeries.

4.2 METHODS OF EXAMINATION

Light rays from the anterior drainage structures form an angle greater than the critical angle that would permit direct imaging of structural detail. Therefore the majority of light returning from the angle is totally internally reflected at the tear–air interface into the anterior chamber (Fig. 4.1) and the angle structures cannot be viewed directly with the biomicroscope alone. Only when the corneal power is neutralised with a plus contact lens (direct) or contact mirror system (indirect) can the structures be visualised. The direct technique uses a high plus (+50D Koeppe) lens[5] that must be used

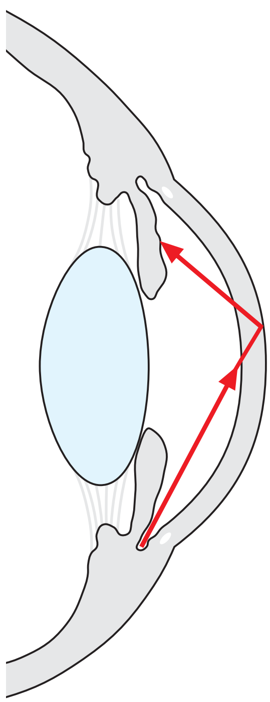

Fig. 4.1 Light from the anterior chamber angle exceeds the critical angle and is totally internally reflected.

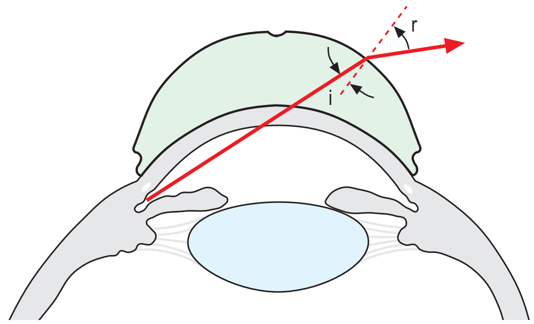

Fig. 4.2 Direct (Koeppe) gonioscope on cornea. Light from the angle is refracted laterally and must be viewed with a hand-held illuminated magnifier.

in conjunction with a hand-held slit lamp or other magnifying instrument despite the 1.5× magnification it provides, as the patient must be in the reclined position. Advantages include a panoramic undistorted view of 360° of the angle and the ability to compare the angles of both eyes simultaneously when a lens is inserted in each eye.[8] The Koeppe lens is rarely used in the modern primary care practice and is generally limited to the examination of infants or children under general anaesthesia or prior to anterior chamber angle surgery (Fig. 4.2).

Indirect gonioscopic lenses provide the method of choice in the routine assessment of the glaucoma suspect or patient.[9] There are many types of indirect lens[10] (see Table 4.3) with mirrors mounted within the lens carrier angled between 59° and 64°. The mirror reflects light from the anterior chamber angle through the front of the lens (Fig. 4.3). This permits a stereoscopic view of the structures within the angle assisted by the magnification and illumination options of the slit lamp biomicroscope. The principle of the gonioscopy contact lens is that the corneal surface is approximately neutralised by the rear surface of the contact lens and the tears formed between this surface and the cornea. A clear coupling fluid is usually used to facilitate contact (see Table 4.4). The image of the angle is in the opposite quadrant to the position of the mirror and forms a reversed image.

The indirect methods have a number of advantages, not the least of which is the ease of use while the patient is seated at the slit lamp and therefore facilitation of the application of laser in procedures

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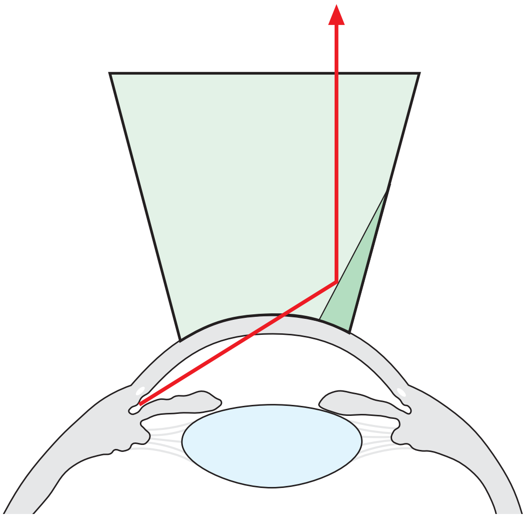

Fig. 4.3 Indirect gonioscope placed on cornea. Light from the opposite angle is reflected from the internal mirror to the front of the lens where the reversed image is viewed with a slit lamp.

such as trabeculoplasty. Focal line and convex iris techniques (see Additional examination techniques) can be performed with these lenses to facilitate diagnostic examination, and compression can be used as a therapeutic technique in angle closure. Disadvantages of the indirect techniques will be discussed in the following section on the lens types.

4.3 TYPES OF INDIRECT GONIOSCOPES[10] (Fig. 4.4)

Two basic types of gonioscope are available which will be designated here as scleral-type and corneal-type lenses because of the contact area of the lenses on the eye. Scleral-type lenses have a broad area of contact and a steep concave surface. A viscous solution must be used to fill the gap between the lens and the cornea in order to obtain an image through the lens. Scleral lenses are available in a range of sizes (including lenses designed for children) with a typical diameter of 15 mm or 18 mm. The most commonly used lens is the Goldmann-type 3-mirror or 'Universal' lens. This lens affords the clinician the further advantage of having two other mirrors (more steeply angled than the gonioscopy or 'thumb-nail' shaped mirror) as well as a central lens to allow stereoscopic evaluation of all areas of the vitreous and retina. Other available lenses include 1, 2 and 4-mirror types.[5,9]

Scleral-type lenses are most commonly used for gonioscopy. Advantages include excellent optics and lens and lid stabilisation even with a blepharospastic patient. The procedure also causes very little if any corneal disruption when a non-preserved coupling solution (such as Celluvisc™) is used. Alternatively, a commercially available gonioscopic solution may be considered for its increased viscosity; however, these solutions are preserved with either benzalkonium chloride or thimerosal (thiomersal) and must be rinsed from the eye to prevent corneal disruption and staining. Because of the wide area of contact, scleral-type lenses cannot be used for indentation (compression) gonioscopy. When the lens is centred, the mirror is located approximately 7 mm from the apex of the cornea so the examiner's technique may need to be altered to view over a convex iris. The focal line or slit technique used to locate Schwalbe's line in a narrow or difficult-to-assess angle can be performed most easily with scleral-type lenses (see Additional examination techniques).

All corneal-type lenses (Zeiss, Posner, Sussman) have four mirrors, generally angled at 64°. The Zeiss lens has a removable handle used to stabilise the lens. The Posner is a lighter version with a permanently attached handle that is angled away from the lens to facilitate manipulation. The Sussman is a hand-held version of the other two. Because the area of contact of corneal lenses is much smaller (9 mm) and the surface is similar in curvature to the cornea, the clinician is more likely to indent the cornea causing folds in Descemet's membrane with very little pressure. This may also cause the clinician to dangerously misinterpret the angle to be artificially wider as the peripheral iris and ciliary body will bow backward with pressure. An advantage of the corneal lens is the deliberate use of the indentation technique to differentiate an appositional- versus a synechial-type angle closure. In addition, the view over a convex iris is facilitated because the mirror is placed approximately 3 mm from the apex of the cornea.

Corneal lenses are easier and faster to use for the experienced gonioscopist. The four mirrors allow a

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Table 4.3 Common gonioscopic lenses[9]

Lens	Type of indirect lens	Gonioscopic solution	Number of gonioscopic mirrors	Comments
Goldmann 3-mirror	Scleral	Yes	1	59° mirror for gonioscopy and far peripheral examination, along with 2 additional mirrors with steeper angles to examine the peripheral (66–67°) and mid-peripheral (73°) retina. Also a central lens for posterior pole examination Available in a variety of sizes down to paediatric 10 mm aperture. Ora serrata attachment available
Goldmann 4-mirror	Scleral	Yes	1	As with the 3-mirror with an additional mirror for retinal examination
1- and 2-mirror lenses	Scleral	Yes	1–2	Smaller lenses that are easier to insert in patients with small lid aperture
Thorpe type	Scleral	Yes	4	No rotation required to view different quadrants, no retinal mirrors
Zeiss	Corneal	No*	4	No rotation required to view different quadrants, handle is removable, compression gonioscopy possible
Posner	Corneal	No*	4	No rotation required to view different quadrants, attached handle is angled to facilitate stabilisation, compression gonioscopy possible
Sussman	Corneal	No*	4	No rotation required to view different quadrants, no handle so is held much like an indirect retinal lens, compression gonioscopy possible

* A viscous solution is not required but examination is facilitated by good optical contact; a viscous solution such as Celluvisc is therefore recommended.

Table 4.4[11] Gonioscopic coupling solutions

Solution	Supplier	Polymer	Preservative
Gonioscopic™	Alcon	Hydroxyethylcellulose	Thimerosal 0.004% edetate disodium 0.1%
Goniosol™	Iolab	Hydroxypropylmethylcellulose 2.5%	Benzalkonium chloride 0.01% edetate disodium
Gonak™	Akorn	Hydroxypropylmethylcellulose 2.5%	Benzalkonium chloride 0.01%
Celluvisc™ (recommended)	Allergan	Carboxymethylcellulose 1% unit dose containers	Preservative free

Approximately a third to half of the reservoir should be filled with solution and be free of bubbles which will interfere with the mirror view. Too much solution will cause some of it to run down the patient's cheek during examination, and too little will cause bubbles in the solution which will block the view of the angle. Gonioscopic, Gonak, and Goniosol are commercially available solutions which provide a clear medium and enable good contact suction with scleral-type lenses. These solutions must be irrigated from the eye after the lens has been removed to minimise irritation and corneal stippling from the large polymer and preservative. Rotation of the lens is most easily accomplished with these solutions. A viable alternative is a viscous unpreserved artifical tear solution such as Celluvisc (carboxymethylcellulose) as it can be used from one single dose vial and need not be rinsed from the eye. Rotation of the lens is marginally more difficult.

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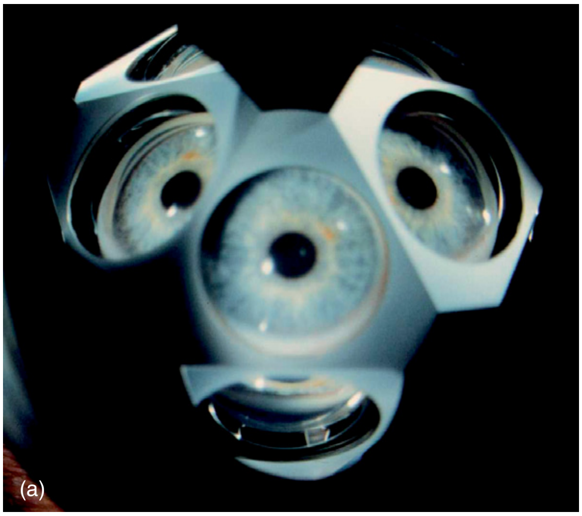

Fig. 4.4a 3-mirror (Goldmann or Universal) scleral-type lens. Thumbnail gonioscopic mirror positioned inferiorly.

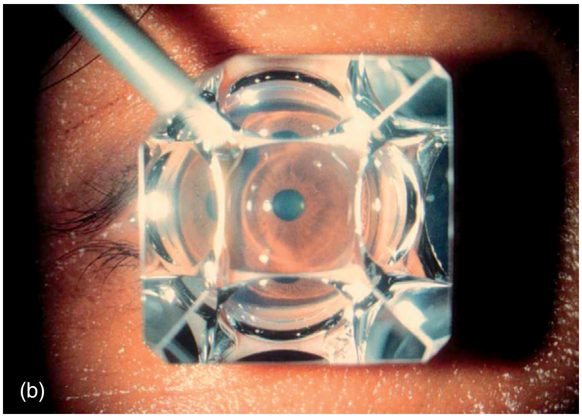

Fig. 4.4b 4-mirror (Posner) corneal-type lens (also very similar to the Zeiss lens).

view of all quadrants by manipulation of the slit lamp only. Examination may be somewhat discontinuous, however, and this can be important when evaluating the angle for suspected abnormalities such as angle recession or neovascularisation. The view of the angle structures is also not as optically distinct or stable as with the scleral lenses so that observation of subtleties and use of the focal line technique are more difficult. Along with folds in Descemet's membrane occurring with excessive pressure, corneal abrasions may occasionally occur

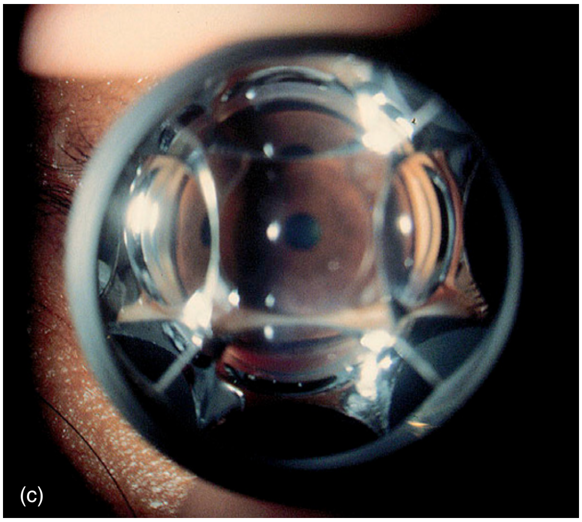

Fig. 4.4c 4-mirror (Sussman) corneal-type lens.

especially in patients with a compromised epithelium. Corneal lenses are very difficult to use in blepharospastic or uncooperative patients.

4.4 TECHNIQUES FOR INDIRECT GONIOSCOPY

Insertion and manipulation of the two main types of indirect lenses, the scleral- and corneal-type lenses, varies according to the lens characteristics (Table 4.5). In both cases, position the patient at the biomicroscope with the illumination coaxial with the viewing system and magnification low (10×). Ensure appropriate alignment with the lateral canthal marker so that the vertical range of the slit lamp is centred and therefore the mirrors may be viewed in all positions without altering the chin rest (Fig. 4.5). Describe the procedure and necessity for angle observation.

4.5 GONIOSCOPIC ANATOMY AND INTERPRETATION (Fig. 4.6)

The examiner must understand the relation between the structures of the iridocorneal angle so that variations and abnormalities can be identified. It is useful to approach the angle evaluation from

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Table 4.5 **Indirect gonioscopic technique**

Scleral-type lenses	Corneal-type lenses
Preparation	
Position patient at biomicroscope with illumination coaxial with viewing system and magnification low (10×). Ensure appropriate alignment with lateral canthal marker and therefore vertical range of slit lamp Clean/disinfect lens surface* Lubricate lens with unpreserved (Celluvisc) solution or commercially available gonioscopic solution (Table 4.4) Support elbow on table/tissue boxes or, once lens is on, with little finger hooked on headrest Anaesthetise both the testing eye as well as the non-testing eye to minimise blink reflex	Position patient at biomicroscope with illumination coaxial with viewing system and magnification low (10×). Ensure appropriate alignment with lateral canthal marker and therefore vertical range of slit lamp Clean/disinfect lens surface* Consider lubricating lens with a drop of saline, anaesthetic, or Celluvisc. Forearm must be fully supported Anaesthetise both the testing eye as well as the non-testing eye to minimise blink reflex
Lens insertion	
Have patient look up and stabilise the upper lid against the brow bone. Pull the lower lid down and introduce the rim of the lens onto the inferior bulbar conjunctiva above the lower lid margin Use lens edge to pull down lower lid further then quickly and gently rotate the lens onto the eye Ask patient to *slowly* look straight ahead It is helpful (but not necessary) to manipulate the lens through a couple of rotations while maintaining sufficient pressure. The suction seal will noticeably 'loosen' Ensure no bubbles have entered behind the lens (if peripheral bubbles have entered, apply pressure to the opposite side of the lens to try to work them out. If large central bubbles have entered such that an image cannot be obtained, remove the lens and reinsert)	Have patient look straight ahead and place the lens directly onto the apical surface so that the edges do not indent the cornea Use backs of fingers to stabilise on cheek Have lens such that the mirrors are placed in the 12, 6, 3 and 9 o'clock positions ('square'). Zeiss and Posner lens handles can be held in either superior or inferior temporal orientations Maintain minimal contact to eliminate air beneath the surface. Watch for folds in Descemet's membrane indicating excessive pressure
Lens manipulation	
Hold lens between thumb and second finger (first finger should be free) Rotate lens by placing first finger on the front of lens and using as a pivot while adjusting the second finger and thumb (this method allows freedom of the other hand to manipulate the slit lamp therefore facilitating an efficient exam where the examiner need not leave the eyepieces or use two hands to turn the lens)	Manipulation is not usually necessary due to the four mirror configuration, i.e. only the slit lamp beam need be moved between the four mirrors Minimal lens tilting can be used to visualise the most posterior structure Indentation (or compression) gonioscopy can be used to differentiate an appositional vs. synechial angle closure

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Table 4.5 Continued

Scleral-type lenses	Corneal-type lenses
Viewing	
Use vertical parallelopiped beam ~2–3 mm wide The quadrant *opposite* the mirror is being viewed Start with inferior angle (place mirror superiorly) as it is the widest and usually has more pigmentation to highlight structures Maintain the parallelopiped in the mirror by manipulating the joystick of the slit lamp to follow the rotating mirror Examine all quadrants in a systematic manner Angles on the nasal and temporal sides may be more easily viewed when the slit beam is on the viewing axis (i.e. horizontal) Use convex iris technique for narrow angle/bowed iris	As per Goldmann Viewing over a convex iris is more difficult as the edge of the lens comes in contact with the cornea if the patient is asked to look toward the mirror. Some tilting can be used, however, to facilitate the view of a narrow angle
Lens removal	
Release suction of the lens by having the patient look toward their nose and blink (strongest lid force nasally) while simultaneously applying pressure through the temporal inferior lid margin along the lens edge to introduce air beneath the lens. When the suction is broken the lens may make a popping sound and should fall forward. Repeat with more pressure temporally if first attempt fails. Do not use pulling force to remove the lens Wash lens with soap and water and dry before storing	Simply release from eye Wash lens with soap and water and dry before storing
Irrigation	
Rinse the superior and inferior cul-de-sacs with irrigating solution (or saline) to prevent blurred vision or discomfort if and only if a preserved coupling solution was used	Not required
Corneal assessment	
Check cornea for staining/disruption	Check cornea for staining/disruption

* A thorough soap and water wash on lens removal followed by a 10-minute soak in either a 1 : 10 dilution of hypochlorite (bleach) or fresh hydrogen peroxide with sterile saline rinse is the most appropriate disinfection of the contact surfaces of the lens. Alcohol has been used routinely in the past but, when used appropriately with surface rubbing, can cause damage to the lens surface with time.

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Fig. 4.5a Scleral-type (Goldmann) lens must be rotated 360° to view all quadrants.

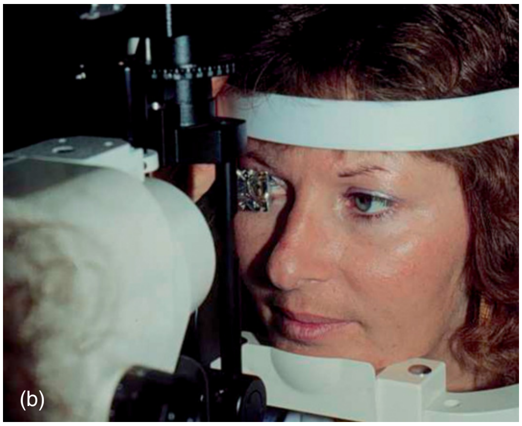

Fig. 4.5b With corneal-type lens (Posner or Zeiss) only the slit lamp joystick needs be altered to view all quadrants.

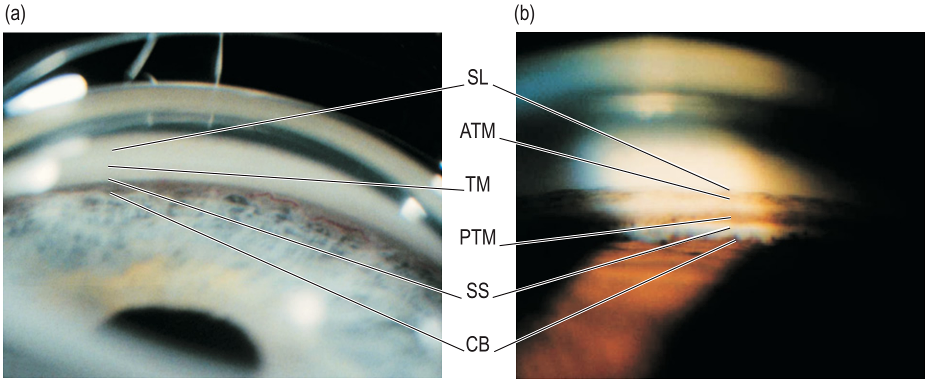

Fig. 4.6 (a) Normal angle (Caucasian), diffuse illumination, low magnification. A very lightly pigmented angle. The faintly gray trabecular meshwork (TM) band is just distinguishable above the dark ciliary body (CB) with scleral spur (SS) in between. A normal vessel is seen, and this is common in patients with lighter uveae. (b) Normal angle (Asian-Oriental), parallelopiped, high magnification. A more heavily pigmented angle. Pigment is evident on Schwalbe's line (SL), below which are seen the anterior (unpigmented) trabecular meshwork (ATM) then the posterior (pigmented) trabecular meshwork (PTM). A bright scleral spur is seen between the PTM and the blackish colour of the ciliary body. Small iris (or ciliary) processes are seen inserting onto the ciliary body.

an *anterior-to-posterior* direction to avoid misinterpretation especially when narrowness and angle variations and abnormalities complicate the textbook appearance. The anatomical structures seen in an open angle (from anterior to posterior) begin at the termination of the cornea at Schwalbe's line, followed by the trabecular meshwork and then scleral spur. The ciliary body, often the most conspicuous structure, is the most posteriorly viewed structure if the angle is widely open.[1–6,8–11]

4.5.1 SCHWALBE'S LINE

Schwalbe's line is a condensation of connective tissue that represents the termination of

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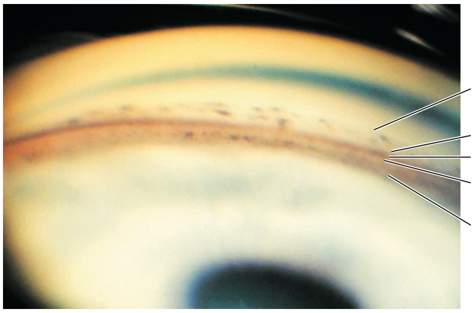

Fig. 4.7 Discontinuous pigmentation deposited in the angle is commonly seen in pseudoexfoliation syndrome. Pigmentation on Schwalbe's line is termed Sampaolesi's line. See Fig. 4.6 legend for abbreviations.

Descemet's membrane or end of the cornea. The appearance of Schwalbe's line is variable but it is a crucial landmark in interpreting the angle configuration. Schwalbe's line is often indistinguishable by direct observation but may be identified using the focal line technique. It may appear as a fine bright white line in some regions of the angle, as a shelf protruding into the anterior chamber, or it may have pigment deposited along it. Pigment deposited in a wavy discontinuous pattern anterior to SL is referred to as **Sampaolesi's line** and has been described in pseudoexfoliation syndrome (see Fig. 4.7). **Posterior embryotoxon** is a prominent SL that extends into the anterior chamber and is often visible directly with the slit lamp as a white line at the temporal limbus.

4.5.2 TRABECULAR MESHWORK

The anterior translucent portion of the trabecular meshwork (ATM) is considered the non-filtering portion of the meshwork. The more posterior and usually more pigmented portion (PTM) overlies the **canal of Schlemm** and is more active in the drainage of aqueous. Aqueous fluid produced and secreted by the ciliary epithelium travels from the posterior chamber around the pupil to the angle where it passes through the specialised multilayered network of fenestrated lamellae and endothelial cells of the posterior meshwork and into Schlemm's canal. The canal surrounds the posterior meshwork circumferentially (deeper into the ocular tissue) and passes the aqueous into the episcleral venous plexus. The canal of Schlemm is suggested by the pigmented portion of the trabecular meshwork but can only be visualised if blood is refluxed back from the venous system. This will occur if pressure is applied to the eye with a large aperture gonioscope such that the pressure in the draining veins exceeds the intraocular pressure. This can also occur in ocular hypotony and other conditions such as carotid sinus fistula.[2]

4.5.3 SCLERAL SPUR

The scleral spur is a white protrusion of the sclera into the anterior chamber on which rests Schlemm's canal and to which attaches the trabecular meshwork anteriorly and the longitudinal muscle of the ciliary body posteriorly. The spur becomes more visible when the ciliary body and trabeculum are pigmented. Visualisation of the spur verifies that the drainage through the trabeculum is unobstructed in the area being observed.

4.5.4 CILIARY BODY

As with other angle structures, the ciliary body band exhibits extensive variation among individuals. Representing the longitudinal muscle of the ciliary body, the ciliary body band may appear black, brown, gray, or even mottled and mixed with white, and is situated just posterior to the scleral spur. Observation of this band allows a quick determination that the angle is wide open. An excessively wide ciliary body band with a history of trauma may indicate angle recession. **Iris processes** are found in approximately one third of normal eyes and are strands of the uvea which project anteriorly onto the ciliary body or scleral spur and occasionally more anteriorly onto the trabecular meshwork (Fig. 4.6b).

4.5.5 IRIS ROOT

The iris root runs from the last roll of the iris and inserts onto and may obscure the view of the ciliary body.

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4.5.6 OTHER GONIOSCOPIC FINDINGS

Pigmentation

Pigmentation is normally present in the angle especially in older patients and those with more pigmented irides, and also in conditions such as pigment dispersion and pseudoexfoliation syndromes (Figs 4.6b and 4.7). Pigment usually deposits most heavily in the inferior quadrant. Trauma and surgery can also cause pigment deposition in the angle.

Peripheral anterior synechiae

Peripheral anterior synechiae (PAS) are abnormal adhesions of the iris to the trabecular meshwork or other angle structures (Fig. 4.8). PAS vary in appearance depending on the aetiology of the adhesion. Angle closure PAS are usually found superiorly where the angle is narrowest whereas inflammatory PAS are more broadly based and are often located inferiorly due to settling of inflammatory debris. Iridocorneal endothelial syndrome often causes severe peripheral anterior synechiae that may advance anteriorly to Schwalbe's line (rare otherwise). PAS due to argon laser trabeculoplasty often appear tooth shaped and can occur if the laser burns are placed too far posteriorly on the pigmented trabeculum or scleral spur.

Iris vessels

Iris vessels from the major arterial circle can be seen as a normal finding in widely open lightly pigmented angles (Fig. 4.6a).

Angle neovascularisation

Neovascularisation in the angle may be preceded by small tufts of rubeosis iridis at the pupillary ruff. The new angle vessels may give the trabeculum a pinkish tone before trunk vessels become visible, bridging the scleral spur.

Angle recession

Blunt trauma may cause posterior displacement and a tear in the ciliary body which manifests as an

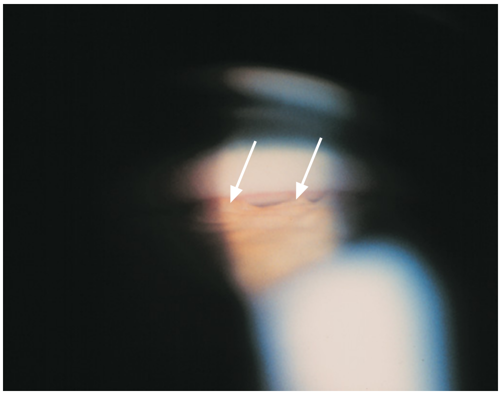

Fig. 4.8 Multiple peripheral anterior synechiae (arrows) in a patient with iridocorneal endothelial (ICE) syndrome.

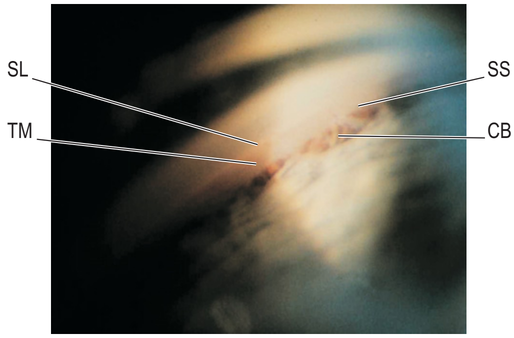

Fig. 4.9 Angle recession following blunt ocular trauma. Note the abnormally wide ciliary body (CB) band in some locations. The trabecular meshwork (TM; greyish band) and Schwalbe's line (SL) are easily distinguished. SS, scleral spur.

angle recession (Fig. 4.9). A widened angle recess (wider ciliary body band) is noted in one or all of the quadrants. Concurrent damage to the trabecular meshwork is the likely cause for the development of angle recession glaucoma. A cyclodialysis cleft, which directs the aqueous into the suprachoroidal space causing hypotony, may also be observed.

4.6 ADDITIONAL EXAMINATION TECHNIQUES

Certain illumination and manipulation techniques can be used to assist the clinician both to diagnos-

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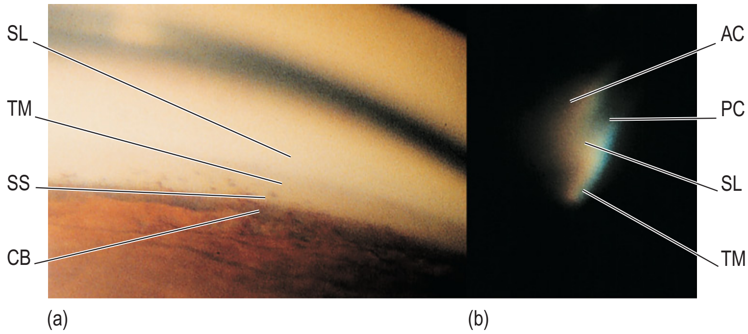

Fig. 4.10 (a) Normal angle. Note the wide mildly pigmented trabecular meshwork (TM) above the narrow white strip of the scleral spur (SS) and band of darker ciliary body (CB). Small flecks of pigment can be seen. Schwalbe's line (SL) is not readily distinguishable. (b) The focal line or slit technique is used to localise Schwalbe's line in narrow and difficult angles. This 'Y' image results from using an optic section, in this case on the right side. The double beam delineates the anterior (AC, left) and posterior (PC, right) surfaces of the cornea. These two come together at the termination of Descemet's membrane (and the cornea) at Schwalbe's line. Below the junction lie the structures of the anterior chamber angle.

tically interpret the gonioscopic view in patients with narrow angles and to therapeutically break an angle closure attack.

4.6.1 FOCAL LINE OR SLIT TECHNIQUE (Fig. 4.10)

The focal line technique is an essential tool for the gonioscopist to master to be able to interpret both narrow and unusual angles. This supplemental technique is used when the angle structures are not unequivocally identifiable by simple inspection.

All of the structures and abnormalities of the angle can be more readily classified if the most anterior angle structure, Schwalbe's line, is first identified. The focal line technique involves projecting a very fine bright optic section at the most oblique angle possible whilst maintaining the section in the mirror of the indirect gonioscope. The corneal section will be observed from the concave surface view and forms a three-dimensional doubled image, much as it is seen in a corneal section in the biomicroscope. The beams of light from the anterior surface will unite or collapse into the posterior surface beam at the termination of the cornea, Schwalbe's line (Fig. 4.10b). The beam will appear to be a two-dimensional (single) line of light from Schwalbe's line posteriorly onto the rest of the angle structures.[5,8] This technique consistently delineates the most anterior angle structure so that significant errors, such as mistaking a pigmented Schwalbe's for the trabecular meshwork, or a pigmented trabeculum for the ciliary body, can be avoided.

4.6.2 TECHNIQUE FOR ANGLE OBSERVATION PAST A CONVEX IRIS

When the view into the angle with a scleral-type lens is obscured by the convexity of the iris, the examiner may facilitate observation over the bowed iris by altering the lens tilt relative to the patient's iris and anterior chamber angle contour. This can be achieved by having the patient look *towards* the mirror (i.e. *away* from the quadrant being viewed) (Fig. 4.11). This allows the anterior plano surface of the lens to be maintained perpendicularly to the viewing axis of the slit lamp, reducing distortions, while at the same time the rays from the deepest part of the angle may get past the forwardly bowed iris. This can also be facilitated by tilting the lens away from the location of the mirror placement. Either way, the clinician should be mindful of the degree of pressure needed to maintain contact of the lens to the cornea and therefore avoid having bubbles introduced in the lens well. This technique is not as useful with corneal-type lenses. However, a slight tilt of the

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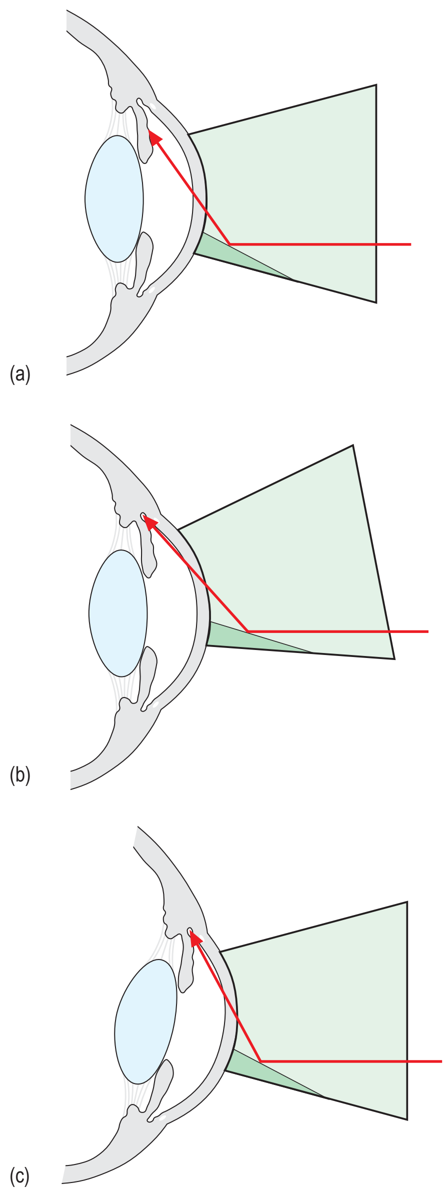

Fig. 4.11 Diagrammatic representation of visualisation over a convex iris with a gonioprism.
Fig. 4.11a and b A corneal lens is represented and is shown in primary position (Fig. 4.11a) and then tilted away from the mirror being used in Fig. 4.11b.
Fig. 4.11c Tilting with a scleral lens is better performed by maintaining the lens in the primary position and having the patient look toward the mirror. This reduces distortion by keeping the flat surface perpendicular to the observation beam.

lens away from the mirror may be used while the patient continues to fixate straight ahead so that contact is maintained.[1,2]

4.6.3 INDENTATION (COMPRESSION) GONIOSCOPY[1]

This technique is invaluable when evaluating a patient with angle closure as it enables a dynamic view of the peripheral iris relative to the trabecular meshwork. It is also used therapeutically to help break a primary pupillary block angle closure attack. Only the corneal-type lenses may be used for this technique; scleral-type lenses merely retrodisplace the globe if pressure is applied.

The angle should first be evaluated with gonioscopy and the cornea cleared with hyperosmotic solution if needed. The convex iris and focal line techniques should be used to determine if Schwalbe's line is visible. Note the line of contact of the iris with the angle or posterior cornea. Observe the angle as pressure is applied directly onto the apex of the cornea (Fig. 4.12). As the scleral ring stretches, the peripheral iris and ciliary body will bow backward and aqueous is forced into the angle. If the previously hidden pigmented portion of the trabecular meshwork becomes visible with indentation, appositional angle closure exists (Fig. 4.12b). Synechial angle closure is evident when PAS continue to obscure the angle structures despite the force attempting to open the angle[5,8] (Fig. 4.12c). This usually occurs when the closure has been recurrent, is long-standing and when inflammation has occurred.

4.7 ANGLE CLASSIFICATION SYSTEMS

A number of grading systems have been proposed to attempt to describe the characteristics of the anterior chamber drainage angle.[1–6] However, these systems may insufficiently describe and therefore complicate the characterisation of the angle because they are either not fully descriptive or vary from one system to the next. For instance, the same label for a wide open angle from one grading system may represent a very narrow angle in another.

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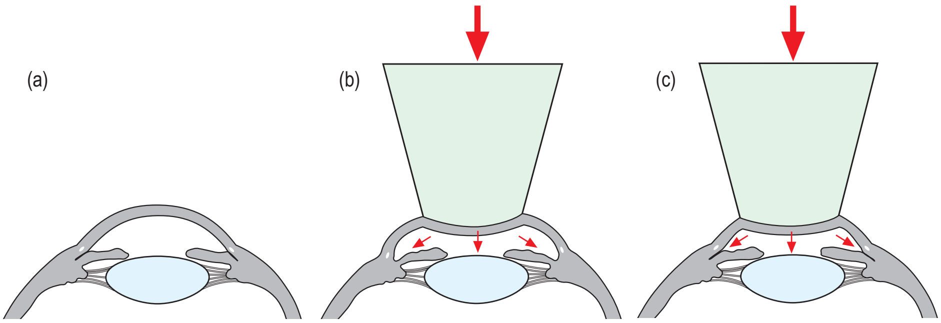

Fig. 4.12a Eye showing angle closure.
Fig. 4.12b Indentation or compression gonioscopy. A corneal lens is used to compress the cornea centrally in an eye with angle closure to attempt to break the attack and differentiate appositional versus synechial angle closure. Appositional closure exists if the previously hidden trabecular meshwork becomes visible with indentation.
Fig. 4.12c An angle with synechial closure remains closed despite compression.

The **Shaffer** system (Fig. 4.13) grades the angle by the estimate of the geometrical angle between the iris and angle wall at the recess. This system most closely correlates with the van Herick angle estimation method where the shadow created by an optical section directed at the lateral (nasal and temporal) limbus is compared to the width of the optic section. Angles grade 3–4 are widely open; that is, the angle depth is one half to one full thickness of the corneal section for a 30–40° approach. In both the van Herick and Shaffer systems, angles designated grade 2 or less are considered *capable* of closure: angle depth of one quarter the optical section and angular approach of 20°, respectively. Angles designated grade 0 are considered closed.

Spaeth expanded the above grading (Fig. 4.14) to include important information such as the peripheral iris contour (regular, steep or queer) and the site of iris insertion (anterior to Schwalbe's line to the ciliary body). Characterisation of all three parts of the Spaeth system are important in

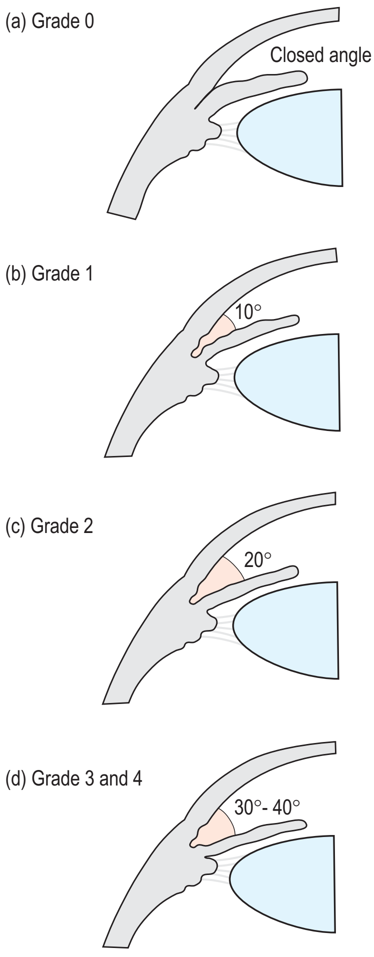

Fig. 4.13a–d Representation of Shaffer grading system demonstrating characterisation by angular approach only. Grade 4 = 40° or more, grade 3 = 30°, grade 2 = 20°, grade 1 = ~10°, slit-like = open only a few degrees, and grade 0 = closed. No designation is given for the contour of the iris or the location of iris insertion.

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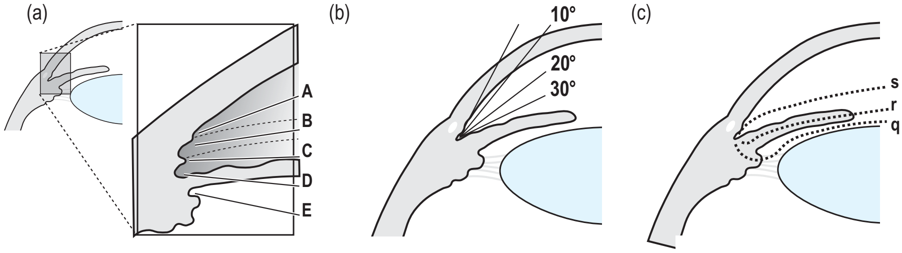

Fig. 4.14a–c Representation of Spaeth grading system. Three criteria are used to describe the angle: (a) the point of insertion on the angle wall (***A*** is anterior to SL, ***B*** is behind SL, ***C*** is at the SS, ***D*** is a deep angle with CB visible, and ***E*** is extremely deep). The iris is shown in an arbitrary position in the figure, but could be as anterior as A or as posterior as E, (b) the angular approach in degrees of the iris at the angle recess, and (c) the configuration of the most peripheral portion of the iris (***r*** for regular, ***s*** for steep, and ***q*** for queer indicating a concave configuration). Therefore C30r represents an angle open to the scleral spur with a regular configuration to the iris and a 30° approach at the angle recess. Adapted with permission from Kanski J. Clinical Ophthalmology, 3rd edn. Oxford: Butterworth-Heinemann, 1994.

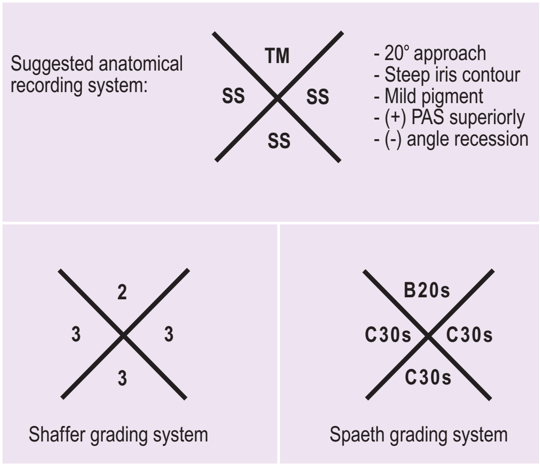

Fig. 4.15 An example of a recording of the suggested anatomical grading system. Comparison is made with the Shaffer and Spaeth systems. Each demonstrates examination in all four quadrants.

determining a patient's risk of both angle closure and other glaucomas.

4.8 SUGGESTED ANATOMICAL RECORDING SYSTEM

Determining the relative openness of an angle is the most common reason for using a gonioscope. However, the anatomy and appearance of the angle vary greatly between individuals and should be accurately recorded. To eliminate the problems of difficult categorisation and the discrepancies between grading systems, it is suggested that the clinician record the angle information in a descriptive way without using a number grade.

Anatomically the anterior chamber angle is widest inferiorly, then temporally, nasally, and is narrowest superiorly.[3] All quadrants should be inspected, preferably in a continuous manner, by following the mirror through 360° of rotation. It is recommended that the inferior angle be examined first as the structures are most easily identified in the widest angle with the most pigment.

The angle should be carefully evaluated and documentation should always include: 1) the most posterior structure seen (location of iris insertion), 2) the approach of the angle at the recess (in degrees) and the contour of the iris, as well as 3) the amount of pigment, and the presence of iris processes, angle recession, peripheral anterior synechiae, and normal and abnormal vasculature (Fig. 4.15).

4.9 SUMMARY

Gonioscopy is the standard procedure for examination of the anterior chamber angle and is a criti-

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cal technique in primary eye care. The clinician must practise the technique and observe many angles as enormous variation can be noted in both normal and abnormal angles by the experienced observer. Gonioscopy is essential to master not only for the assessment of a patient's risk for angle closure with dilation, but also in the diagnosis and subsequent management of the open and closed angle glaucomas and many other anterior segment anomalies.

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Disclaimer: The authors have no proprietary interest in the equipment outlined in this article.

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