GONIOSCOPY

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INTRODUCTION

This chapter includes a review of:

- Theory
- Direct gonioscopy
- Indirect gonioscopy
- Lenses used in gonioscopy
- Pertinent angle anatomy
- Interpretation of gonioscopy findings

INTRODUCTION

Gonioscopy is a clinical technique that provides a view of the anterior chamber angle anatomy. The use of gonioscopy is indicated in circumstances of narrow anterior chamber angles by Van Herrick estimation, suspicion of anterior chamber angle abnormalities (resulting from trauma, maldevelopment, chronic anterior uveitis or neoplasia), pigmentary dispersion, pseudoexfoliation, risk of iris or angle neovascularization, suspicion of glaucoma (differentiation of open angle versus closed angle glaucoma), and established glaucoma patients (monitoring). The use of gonioscopy is contraindicated post-operatively and in cases of traumatic hyphema, corneal abrasion, lacerated or perforated globe.

THEORY

Light strikes the anterior corneal surface at an angle greater than the critical angle causing total internal reflection (Fig. 4.1).

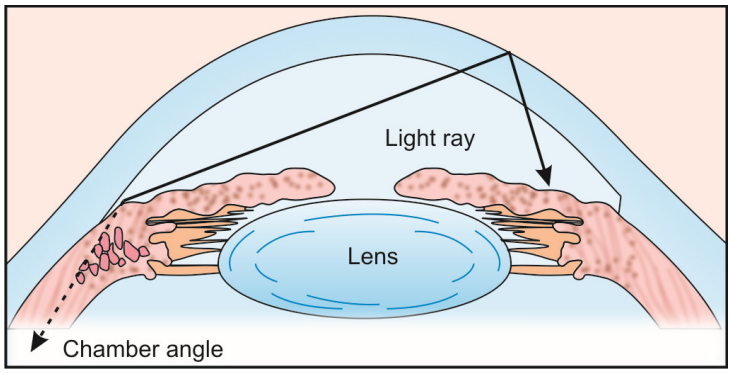


Figure 4.1 *Optics of light illuminating the angle of the anterior chamber*

Despite this optical property, it is possible with the use of specialty lenses or prisms to view the anterior chamber angle structures (Fig. 4.2). The two basic types of contact instruments used to perform gonioscopy are the direct lens and the indirect lens.

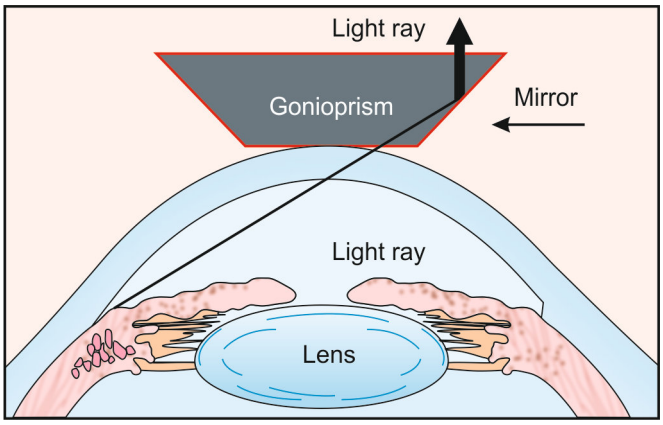


Figure 4.2 *Optics of light illuminating the angle of the anterior chamber with a gonioprism in place*

TYPES OF GONIOSCOPY

DIRECT GONIOSCOPY

The direct gonioscopy system consists of a highly convex glass or plastic lens, an external light source and a hand-held magnifier. The most common direct lens is the **Koeppe** lens (Fig. 4.3), which is a +50D convex lens available in several different diameters. The lens provides 1.5X magnification, but one requires the use of a hand-held slit lamp or other magnifying instrument. Typically a 16X hand-held magnifier is employed providing a total magnification of 24X. The image is **erect** and **virtual**.

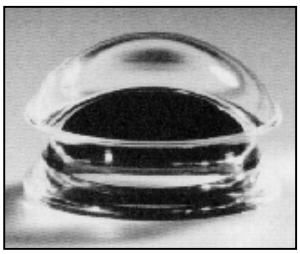


Figure 4.3 *Koeppe lens*

The patient is examined in a supine position and the lens is placed on the eye with saline or a clear viscous preparation to provide a clear refractive medium. The clinician moves freely around the patient to obtain a direct **panoramic** view of the anterior chamber angle structures. The technique is seldom used with the exception of examination under anesthesia for infants or children.

INDIRECT GONIOSCOPY

With the advent of slit lamp biomicroscopy, the indirect method has become popular and much more commonly performed than direct gonioscopy. Indirect lenses use a mirrored system or silvered prisms to allow for examination of the anterior chamber angle structures. This view can be magnified using the slit lamp magnification system. However, some indirect lenses have some magnification built in already (e.g. 1.5X). The angle under observation is opposite (180°) the mirror being used. For instance, if the mirror/prism is placed superiorly, the inferior anterior chamber angle is being examined. The image is **inverted** and **virtual**.

There are various types of indirect lenses. They differ in the amount of ocular contact imposed by the lens diameter and by the number of mirrors/prisms within the system.

INDIRECT SCLERAL LENSES

Scleral lenses have a large diameter of ocular surface contact including the entire cornea, limbus and a portion of the sclera. The most commonly used scleral lens is the **Goldmann** (Fig. 4.4). The Goldmann has one to three mirrors. The one mirror Goldmann lens has a central lens to view the posterior pole and a mirror placed at 62° to view the anterior chamber angle structures. The two mirrored Goldmann lens has a central lens to view the posterior pole and two mirrors placed at 62° which are separated by 180° to view the anterior chamber angle. The three mirrored lens has a central lens (C: circular) to view the posterior pole, one mirror placed at 59° (A: U-shaped) to view the anterior chamber angle and 2 retinal mirrors placed at 66° (P: rectangular) and 76° (E: trapezoidal) to view the periphery and the equator respectively. One is required to rotate the lens around in order to view the entire anatomy of the structure being evaluated.

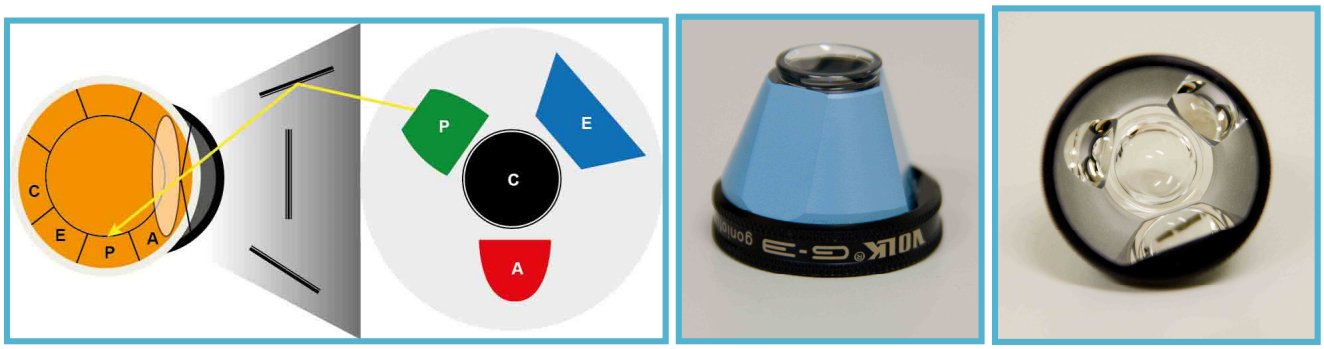


Figure 4.4 *Goldmann 3 mirror lens (A: Anterior, P: Periphery, E: Equator, C: Central)*

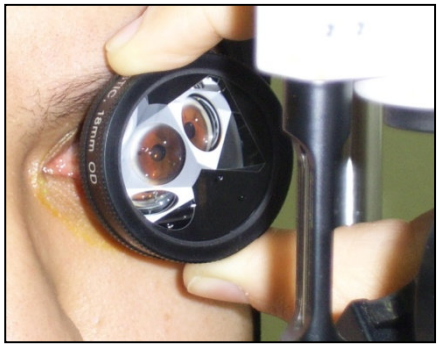


Figure 4.5 *Goldmann lens placed on the eye*

Picture courtesy of Pirindha Govender (University of Kwazulu Natal)

Other scleral lenses that are available include “Goldmann type” lenses by Ocular Instruments (Fig. 4.6), and the Thorpe four-mirrored lens. The Thorpe four-mirrored lens is similar to the Goldmann design, but all four mirrors are placed at a 62° angle to view the anterior chamber angle anatomy only and therefore require minimal rotation to view the entire angle.

Figure 4.6 *Other Goldmann lenses*

Scleral lenses require the use of a viscous lubricant medium between the cornea and the lens to provide a smooth refractive surface and a cushion between the lens and the cornea. Traditionally used gonioscopic solutions include specially made viscous gels such as Gonioscopic gel, Goniosol, Gonak and Teargel. Presently, it is common to use a less viscous solution such as the ones used for dry eye therapy (e.g. Celluvisc) because they do not disrupt the corneal surface. If the more viscous lubricants are used, it is recommended to store the bottles upside-down to avoid the introduction of air bubbles into the solution. A list of gonioscopic solutions follows.

Table 4.1 *Comparison of Gonioscopic Solutions*

Solution	Manufacturer	Material	Preservative
Celluvisc	Allergan	1% carboxymethylcellulose	No preservative
Goniosol	Iolab	2.5 % hydroxypropyl methylcellulose	0.01% benzalkonium chloride edetate dissodium
Gonioscopic	Alcon	hydroxyethyl cellulose	0.004% thimerosal 0.1% edetate dissodium
Gonak	Akorn	2.5% hydroxypropyl methylcellulose	0.01% benzalkonium chloride
Teargel	Novartis (formerly Ciba Vision)	Carbopol 980	0.01% cetrimide
Genteal Gel	Novartis	0.3% hydroxypropyl methylcellulose Carbopol 980	sodium perborate

INDIRECT CORNEAL LENSES

Corneal lenses have a small diameter and the surface of contact does not extend past the limbus. The lenses have multiple silvered mirrors which are used to view the anterior chamber angle. The advantage to this system is that there is no need to rotate the lens while it is on the eye to view the other angles. The disadvantage of corneal lenses is that they provide less stability than scleral lenses. However, unlike the indirect scleral lenses these can be used to perform indentation gonioscopy. This is useful to differentiate between appositional and synechial angle closure as well as evaluating for plateau iris. The different types available are the Zeiss 4-mirrored lens, Posner 4-mirrored lens, and the Sussman 4-mirrored gonioprism.

***Table 4.2**. Comparison of various 4-mirrored lenses*

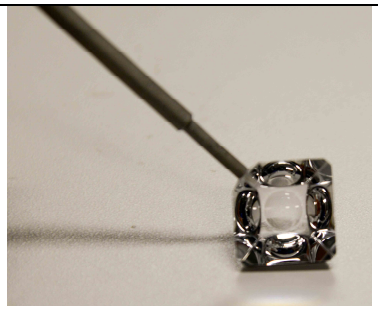
Zeiss 4-mirrored lens	Posner 4-mirrored lens	Volk 4-mirrored gonioprism
▪ Contains a central lens to view the posterior pole/fundus and four mirrors placed at 64° to view the anterior chamber angle structures. ▪ The lens system is attached to a removable handle which is used to manipulate the lens.	▪ Similar to the Zeiss design, but its handle has a steeper angle of attachment and is permanently mounted.	▪ Similar to the Zeiss in lens design, however it does not have a handle.
		

***Table 4.3.** Comparison of various Indirect Lenses*

Lens	# of mirrors/prisms	Contact surface	Coupling Fluid
Goldmann	1 to 3	Scleral	Yes
Ocular Instruments	1 to 3	Scleral	Yes
Thorpe	4	Scleral	Yes
Zeiss	4	Corneal	No
Posner	4	Corneal	No
Sussman	4	Corneal	No

As previously stated, indirect gonioscopy lenses are more widely used than direct lenses. The chart below outlines the advantages and disadvantages of both systems.

Table 4.4. Advantages and disadvantages of indirect and direct gonioscopic systems

	Advantages	Disadvantages
Indirect	• Upright patient position • Quickly and easily performed • Can alter beam width to optic section • Performed in conjunction with • Does not require an assistant • Higher magnification available • Greater detail viewed	• Cannot simultaneously compare eyes • Limited in pediatric cases • Stereopsis poor in lateral views
Direct	• Direct panoramic view • Simultaneous view of both eyes • Useful in pediatric cases • Stereopsis good in lateral views	• Supine position is cumbersome • Time consuming • Requires hand held magnifier • Requires external light source • Usually requires an assistant • Can't alter beam width to optic section

PERTINENT ANATOMY

In order to visualize and understand the iridocorneal angle properly, it is necessary to review anterior chamber angle anatomy. One can often easily perceive and assess the relevant structures from posterior to anterior. However if Schwalbe's line, the most anterior structure, is not properly localized it can lead to misinterpretation. It is therefore safer to evaluate the structures from anterior to posterior in order to reduce error in interpretation. The structures from anterior to posterior are Schwalbe's line (SL), Trabecular Meshwork (TM), Scleral Spur (SS), Ciliary Body (CB), and the Iris Root (IR).

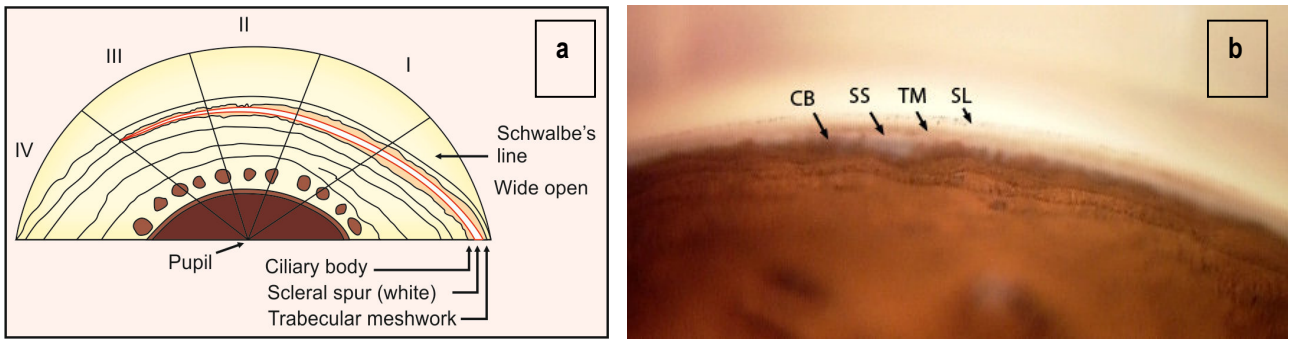


Figure 4.7 *(a) Schematic of structures within the angle (b) Photo of structures within the angle*

Photo courtesy of Ike Ahmed and Graham Belovay (University of Toronto)

SCHWALBE'S LINE (SL)

Schwalbe's Line is the juncture between Descemet's membrane of the cornea and the trabecular meshwork. Its color varies from clear/white to light brown. Circumventing currents of the aqueous may cause pigments to deposit at the junctures of Schwalbe's line causing it to appears dark brown, in which case it is referred to as Sampaolesi's line. To properly localize Schwalbe's line (which is most often non-visible) one must use an optic section that is aligned perpendicular to the mirror and placed at an oblique angle (1-10°). The light will appear to be in the shape of a wedge. Optically, two lines of light will be visible. The lines are formed from the anterior and posterior surface of the cornea. The point at which the lines meet marks the end of Descemet's membrane, the actual location of Schwalbe's line (Fig. 4.8).

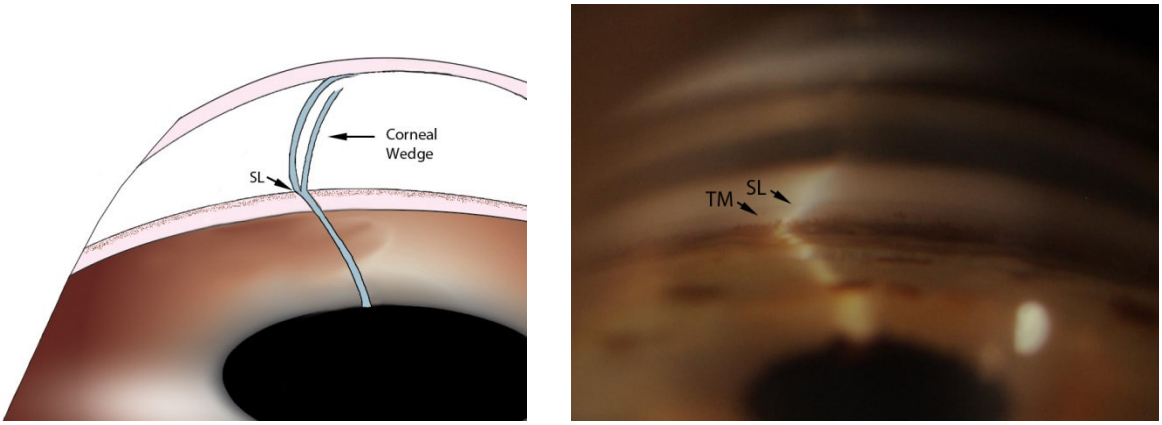


***Figure 4.8**. Using the corneal wedge technique to localize Schwalbe's line*

Picture courtesy of Ike Ahmed and Graham Belovay (University of Toronto)

TRABECULAR MESHWORK (TM)

The trabecular meshwork consists of a series of sheets of fenestrated epithelial tissue which account for the major portion of the aqueous drainage system (80-90%). The coloring of the TM depends on personal pigmentation and can vary from light gray to dark brown. The TM can divided into three parts: uveal meshwork, corneoscleral meshwork and juxtacanalicular meshwork. The juxtacanalicular meshwork is the site of greatest resistance with 0.5-2.0 µm pores. Debris such as that found in pigment dispersion syndrome is deposited in the corneoscleral meshwork. The aqueous humour, produced by the ciliary body, travels over the anterior surface of the iris, circulates and passes through the lamellae of the TM: uveal meshwork to corneoscleral meshwork to juxtacanalicular meshwork. Once through the juxtacanalicular meshwork the aqueous enters Schlemm's Canal (SC). The SC is not visible unless pressure is applied on the eye with the goniolens. If pressure is applied, blood from the venous system regurgitates into SC and it is seen as a fine red line beneath the TM. From SC, the aqueous drains into the episcleral venous plexus.

SCLERAL SPUR (SS)

The scleral spur consists of collagen and elastic tissue from the sclera. Appearing whitish-gray, it protrudes into the anterior chamber and is visible just posterior to the TM. The scleral spur functions as the point of insertion for the longitudinal muscles of the ciliary body.

CILIARY BODY

The ciliary body varies in color from light gray to dark brown depending on personal pigmentation. The portion that is visible consists of longitudinal muscle and is referred to as the ciliary body band. The function of the ciliary body is to produce aqueous humour.

IRIS ROOT (IR)

The iris root is the last role of the peripheral iris. Inserting onto the ciliary body, it varies in color depending on personal pigmentation.

IRIS PROCESSES

In certain individuals, fine strands of iris tissue or uveal meshwork extend into the anterior chamber, span across the CB and SS and insert into the TM. It is unclear why they occur. It is necessary to distinguish iris processes (a normal entity which does not interfere with aqueous outflow) from iris/angle neovascularization or peripheral anterior synechiae (which impairs aqueous outflow). Indentation or compression gonioscopy is performed to determine this difference. Peripheral anterior synechiae continues to hold against the wall while iris processes appear lacier and expose the wall behind them.

IRIS/ANGLE NEOVASCULARIZATION

Iris neovascularization is referred to as Rubeosis Iridis (RI). It occurs in cases of ocular or systemic ischemic/vascular disease. Neovascularization begins at the pupillary margin or ruff and travels over the angle structures. A fibrovascular membrane may develop which would contract and cause the angle to close. The vessels are red and their appearance may be very subtle.

PERIPHERAL ANTERIOR SYNECHIA (PAS)

PAS are adhesions of the iris to the TM or to more anterior structures of the anterior chamber angle (Figure 4.9). They can be found in cases of angle closure, inflammation, trauma, ICE syndrome and following argon laser trabeculoplasty (ALT).

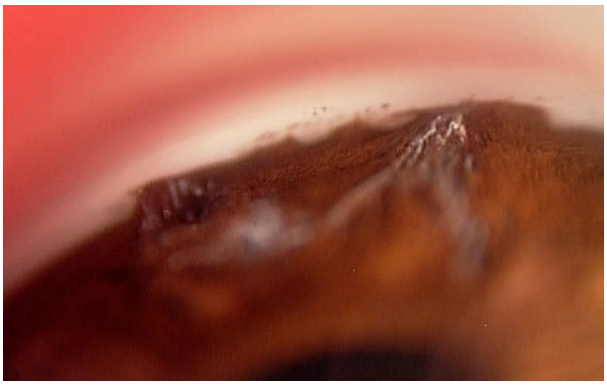


***Figure 4.9**: Image of the angle showing peripheral anterior synechia (PAS)*

Picture courtesy of Ike Ahmed (University of Toronto)

PROCEDURES

INDIRECT SCLERAL LENS

- Position the gonioscope as you would for fundus biomicroscopy (refer yourself to chapter 3) but use the "A" mirror (thumbnail or D shaped) for visualization of the angle.

***Figure 4.10**. Patient seated comfortably at slit lamp during gonioscopy procedure*

Picture courtesy of Pirindha Govender (University of KwaZulu Natal)

***Figure 4.11**. Scleral indirect gonio lens insertion technique*

Picture courtesy of Ike Ahmed and Graham Belovay (University of Toronto)

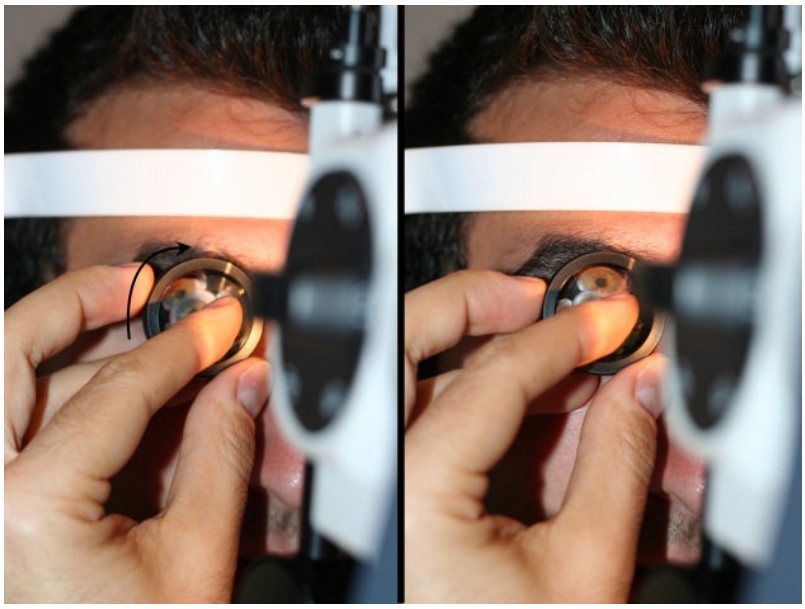


***Figure 4.12**. Rotation of the gonio lens using one hand technique*

Picture courtesy of Ike Ahmed and Graham Belovay (University of Toronto)

***Figure 4.13** Examiner resting his hand on the forehead rest*

Picture courtesy of Pirindha Govender (University of KwaZulu Natal)

INDIRECT CORNEAL LENS

- Patient is educated and the cornea is anesthetized
- The lens is properly disinfected and rinsed
- A drop of saline (or an additional drop of anesthetic) is placed on the concave surface of the lens
- The patient is seated comfortably behind the slit lamp
- The SL is in “click” position (angle of 0°); a wi de 2-3 mm parallelepiped is used
- The SL is fully retracted or moved out of the way towards the eye not being examined
- The patient is instructed to look straight ahead and the lens is placed directly on the eye
- Mirrors should be at 3, 6, 9 and 12 o’clock positions
- The examiner’s hand is stabilized on the side of the head rest or on the patient’s cheek
- Gentle pressure is placed against the corneal surface

- The examiner positions himself behind the SL and moves it forward to obtain a focused view
- To view another angle, the slit beam is simply moved to another mirror
- The lens is removed by releasing pressure on the corneal surface

TIPS

If too much pressure is applied, folds in Descemet's membrane will appear and this will distort the view of the angle structures.

Disinfection of **all** lenses should be performed by washing with soap and water after use and soaking for 10 minutes in a 1:100 bleach:water solution and then rinsing with saline prior to use. Routine disinfection with alcohol will damage lens surfaces and it does not provide adequate disinfection and therefore it is not recommended.

In the circumstance where all the structures are not visible certain techniques are used better examine the angle. For instance, when the iris has a more pronounced convexity, it may be difficult to evaluate which structures are visible. To more easily view the angle structures, the patient is instructed to look slightly towards the mirror. Some sources recommend a technique of tilting the lens away from the mirror, however this may produce distortions.

Another special technique is performed to differentiate an angle closure from synechial closure. It is termed **indentation, pressure or compression gonioscopy** and can **only** be performed with indirect **corneal** lenses. While the lens is placed on the eye and the angle is in view, press lightly on the cornea. This pressure forces the aqueous peripherally into the angle recess and this pushes the peripheral iris backward in cases of angle closure. Once the iris is pushed backwards, the other angle structures will come into view. If a patient has peripheral anterior synechia and indentation/pressure gonioscopy is performed, the peripheral iris will not bow backwards to reveal the angle structures and the areas of adherence become visible.

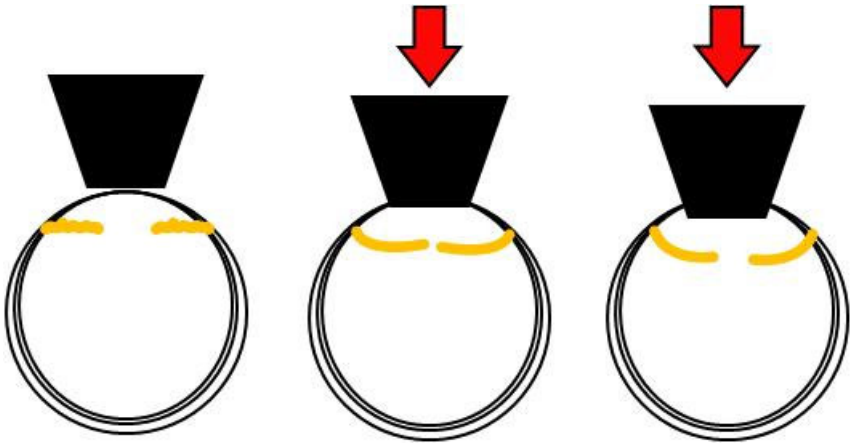


Figure 4.14 *Schematic of indentation/pressure/compression gonioscopy*

ANGLE CLASSIFICATION

Once gonioscopy is performed, it is necessary to grade and document the appearance of the angle structures. This is done with the use of angle classification schemes. The three available angle classification schemes are the Scheie, Schaefer and Spaeth.

SCHEIE'S CLASSIFICATION

The Scheie angle classification scheme (Table 4.5) is based on the most posterior angle structure visible and from that anatomical landmark, it is given a grade from I to IV (Schacknow and Samples, 2010).

***Table 4.5**. Grading the angle of the anterior chamber using Scheie's classification*

Grade	Anatomical Landmark
0	All angle structures visible (wide open)
I	Scleral Spur (open)
II	Trabecular Meshwork
III	Schwalbe's line
IV	No angle structures visible (narrow/closed)

SCHAEFER'S CLASSIFICATION

The Schaefer angle classification scheme requires the observer to estimate the geometric angle between the iris insertion with the plane of the TM (Fig. 4.14). Once the angle is estimated in degrees, a grade is given from I to IV and the risk of angle closure is predicted (Table 4.6).

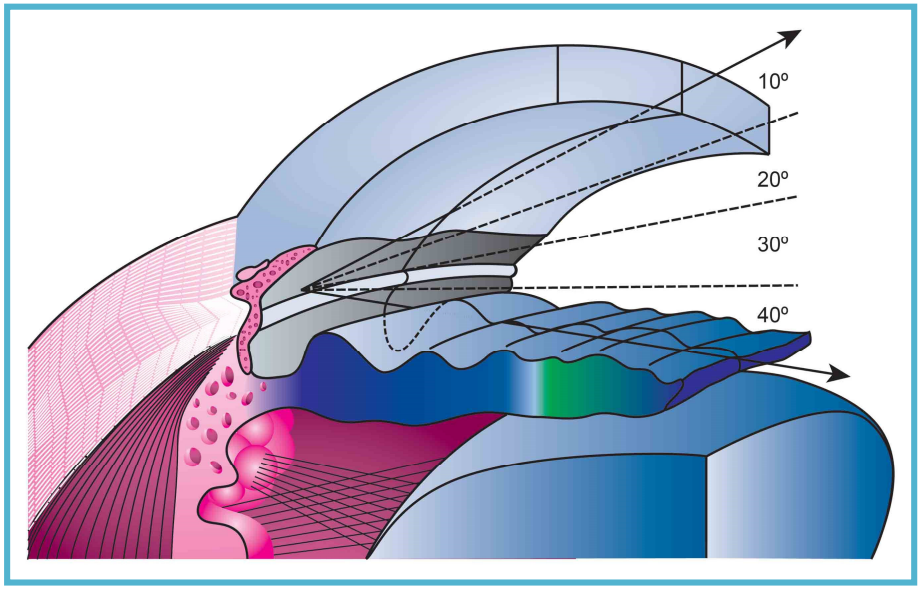


***Figure 4.14** Estimating the geometric angle between the iris insertion with the plane of the TM*

***Table 4.6**. Grading the angle of anterior chamber using Schaefer's classification*

	Grade	Angle in Degrees	Risk of Closure
IV	wide open	≥ 45°	unlikely
III	open	20°<45°	unlikely
II	moderate narrow	20°	possible
I	very narrow	10°	probable
slit	extremely narrow	< 10°	present
0	closed		closed

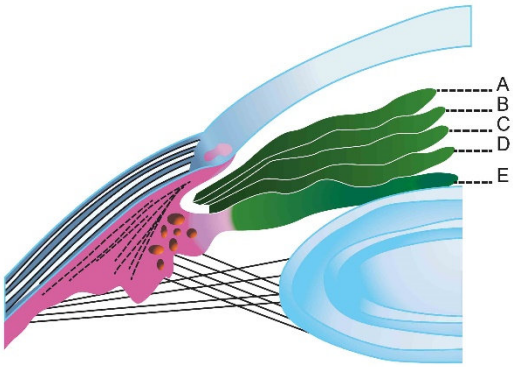
Note: The Scheie and Schaffer classifications were originally described as above with Grade 0 being open and grade 4 closed. Being the opposite of the Van Herrick classification, this created some confusion and practitioners started reversing the grading to match the VH. However, the inconsistent grading scheme, which is now found in many textbooks, created additional confusion. To clarify this and facilitate interpretation, clinicians began to describe the structures seen in each quadrant instead of assigning a number to the angle. The most recent system of angle classification, the Spaethe method described below, is becoming the new standard because it does away with any confusion by providing a clear angle description without using grading numbers.

SPAETH'S CLASSIFICATION

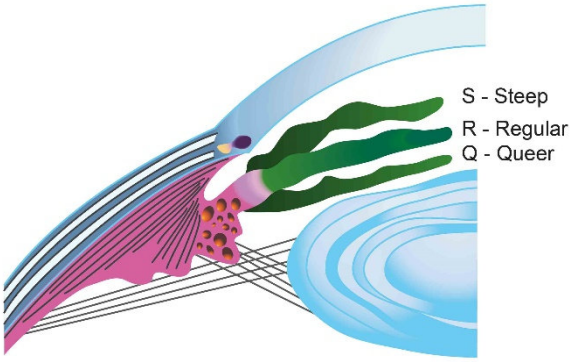
The Spaeth angle classification scheme (Table 4.7) incorporates the angular width of the Schaefer scheme with documentation of the location of iris root insertion into the angle and a description of the iris contour configuration (Kunimoto et al, 2004). The Spaeth angle classification is the most complex, yet it is the most descriptive and comprehensive scheme. Therefore, we recommend it as a primary means to classify and grade the anterior chamber angle when performing gonioscopy.

***Table 4.7**. Grading the angle of the anterior chamber using Spaeth's classification*

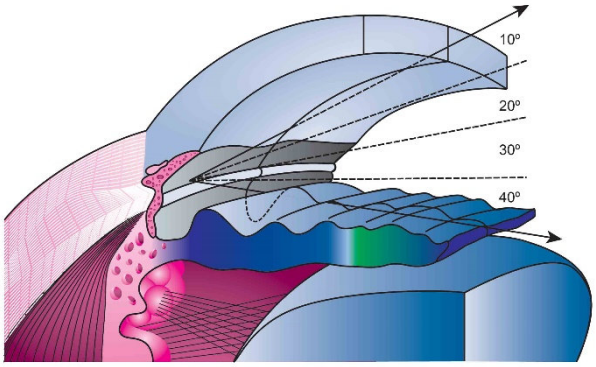
Site of Insertion	
A	**A**nterior to SL
B	**B**ehind SL - no TM visible
C	s**C**leral spur
D	**D**eep angle with CB visible
E	**E**xtremely deep (>1mm ciliary body)



Iris contour/approach	
q	**q**ueer: marked concave iris
r	**r**egular configuration - slight anterior bowing
s	**s**teeply convex iris



Insertion angle	
	in degrees



EXAMPLES

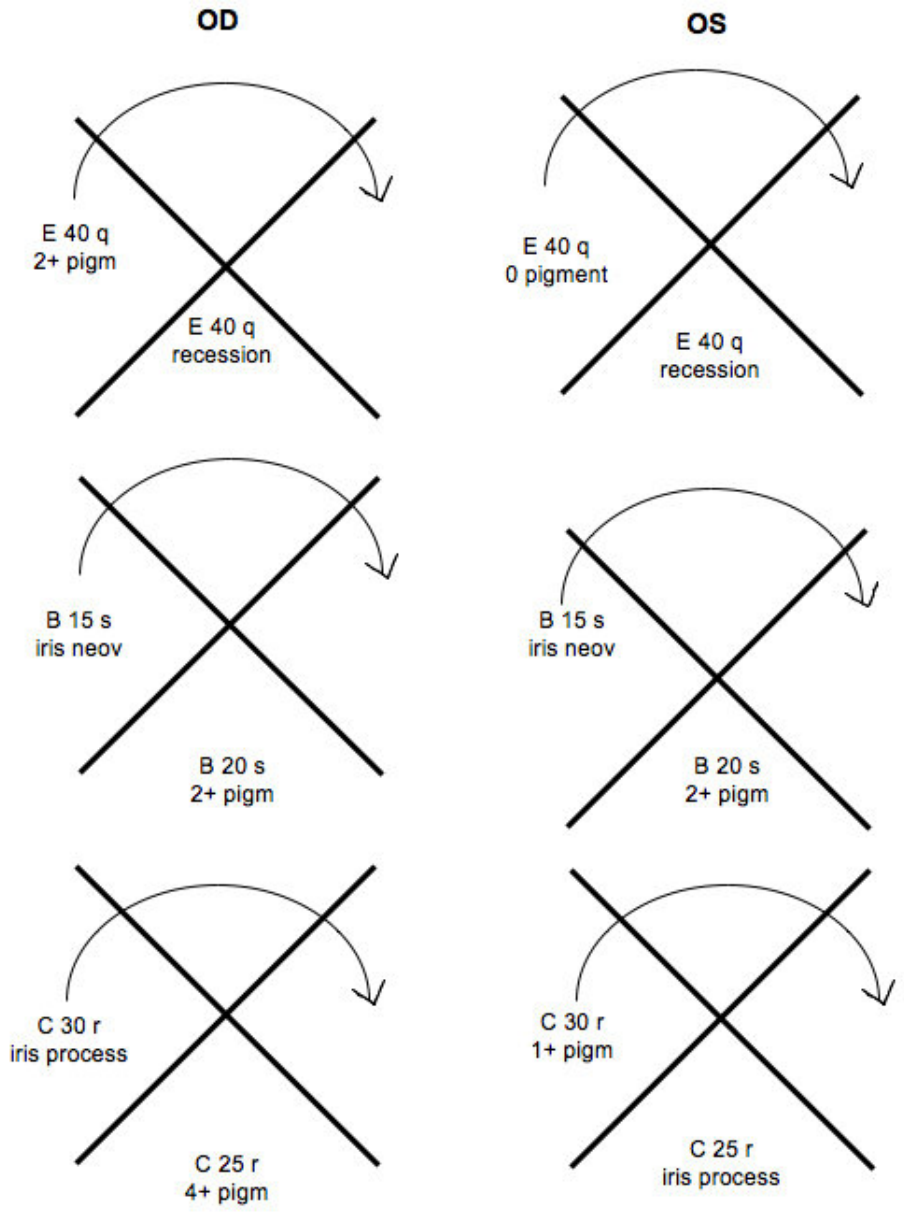
E 40 q = extremely deep iris insertion, 40° insertion angle, queer approach.

B 20 s = iris inserts behind the SL, 20° insertion angle, steeply convex approach.

C 30 r = iris inserts at the scleral spur, 30° insertion angle, regular or flat approach.

NOTATION

With any grading system, a cross is used to document the angle in each quadrant (S,I,T,N). Abnormalities are noted and the amount of **pigment** visible within the angle (mainly in the TM) is also graded 0 to 4+.



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