Gonioscopy

Part 2

The first part of the two-part article reviewed the indications and contraindications to performing gonioscopy, the optics of the procedure, and the types of goniolens. In this second part, Dr Michael E Johnson adopts a practical ‘how to’ approach to the technique and discusses the recording of observations. Common variations of normal anterior chamber angles and angle abnormalities that are seen in primary eye care will also be described. Module C14116, one specialist CET point for AS, SP and IP optometrists, one general CET point for optometrists

Becoming competent in gonioscopy requires the ability to identify angle structures that even in normal eyes demonstrate considerable variability. It also demands an appreciation of mirrored imagery and good dexterity. In my opinion it is the most challenging ocular diagnostic technique. Difficulty in reliably obtaining a good view and uncertainty as to what is being seen is normal for clinicians learning gonioscopy. There are no short-cuts to gaining proficiency and so when starting it is necessary to practice gonioscopy with as many eyes as possible, rather than reserving the technique for just those eyes in which it is especially important. Contact lens patients are often good for improving familiarity with the technique because these individuals are used to having something in their eye, and no-fluid goniolenses can even be applied to the surface of a soft lens without the instillation of an anaesthetic. Images are better than any text. Description and so I recommend viewing the excellent video clips at www.gonioscopy.org. If possible it is also extremely helpful to arrange to observe at a local glaucoma clinic.

Preparation

Instruction

Patients need to be told why it is necessary to put a lens on their eye. As a suggestion of what to say: ‘I want you to look in the corners of the eye where its internal fluid drains. This is because problems with the drainage of fluid from the eye can cause glaucoma. The drain of the eye is hidden from view and to see it I need to put a lens on to the tear film, on the eye’s surface’. Patients should be reassured that the eye will not be painful, although they may have an awareness of gentle pressure or coldness. Some clinicians suggest that warming the goniolens improves tolerance. If a Goldmann-type lens is to be used then patients should also be warned that during the procedure the coupling solution may dribble onto the face, and that this is not harmful.

Set up

An anaesthetic instillation is required before gonioscopy. Alternatively, no-fluid goniolenses is possible to not anaesthetise the eye by the prior insertion of a soft contact goniolens. Anaesthetic instillation does not need to be repeated if it has already been done for annulation of a Goldman lens. Anaesthetic instillation of the reactive globes has been done for all patients with twitchy eyelids or where a longer than normal examination is anticipated. I prefer to instil a second drop. One of the keys to successful gonioscopy is that the clinician and patient be in a correct and comfortable position. Some clinicians find it helpful to support the elbow to enable steady holding of the goniolens on the eye.

Technique

Goldmann-type lens specifics

The goniolens should be positioned with its concave surface upwards to receive a viscous coupling solution, such as carbomethylocellulose (e.g. Celluvisc) or carbomer gel (e.g. Viscotears). The lower viscosity of the coupling solution, the greater the chance of the goniolens lifting from the eye during the examination and so introducing air bubbles that disturb viewing, particularly when turning the lens on the eye. However, advantages of lower viscosity coupling solutions are that they are less likely to interfere with subsequent viewing of the fundus before moving to the patient with sticky eyes and blurred vision. It is useful to store the bottle of the coupling solution upside-down to avoid air bubbles. With very viscous solutions it may also be of value to start a stream of fluid on to the patient’s eye and vice versa, corneal side up and tilted at about 45° towards the globe, the little finger of the hand holding the goniolens is used to retract the lower eyelid of the patient. Then the lower edge of the lens engages and fully retracts the lid downward. Finally, the goniolens is touched onto the eye and rapidly tilted into an upright position as the patient is asked to slowly look straight ahead. This should expel any trapped air upwards.

When viewing the angle, most clinicians apply the lens so that the mirror is at the top of the eye. This is to allow the inferior angle to be examined first. The inferior portion of the angle is typically the widest and is where the trabecular meshwork has the most pigment, and so it is the easiest to identify structures and become familiar with the...
appearance of a patient's anatomy. After the inferior angle has been assessed, the goniolens is rotated to view another portion of the angle. When the angle has been examined in its entirety the goniolens is sometimes sucked onto the eye and resists removal. The air-tight seal between the goniolens and the eye can usually be broken by asking the patient to blink hard. If this is not successful, the lens can be slid towards the sclera across the scleral surface. Rarely it is necessary to apply pressure through the edge of the lens to indent the globe to break suction.

Zeiss-type lens specifics
Coupling solution is generally not needed with these flatter goniolenses. However, a small drop of artificial tears to the concavity of the lens improves optical contiguity in patients with dry eye or marked corneal irregularity, and may enhance goniolens transmission.

To apply the goniolens the patient is positioned at the slit lamp and asked to look straight ahead. The handle of the goniolens, or the lens itself, is held between thumb and forefinger, with the remaining three fingers braced against the patient's face (left hand for right eye and vice versa). I personally use the index finger to support the upper eyelid and the remaining fingers to brace against the sclera. While looking around the side of the biomicroscope the goniolens is applied directly onto the centre of the cornea. A delicate touch is needed to apply the correct level of pressure with the lens. Too much pressure causes Descemet's membrane to wrinkle, which prevents a quality view of the angle and, of more concern, forces aqueous into the recesses of the angle and artificially deepens the angle. Too little pressure allows air bubble to gather beneath the goniolens, which prevents viewing of the angle. The optimal level of pressure has very narrow tolerance limits, and should not be reduced by sliding the goniolens in the direction of the mirror being used. It should be noted that the corneal wedge often appears as obvious as it does in non-photographic representations in textbooks. Owing to the design of slit lamps, it is usually only possible to view the corneal wedge in the superior and inferior angles because decoupling of the illumination and observation systems is displaced to create an optical section of the cornea (Figure 2). When correctly focused, the corneal light reflex from the inner aspect of the cornea will be sharp and that from the outer corneal surface will be slightly hazy. The latter curves as it approaches the angle to meet the reflected light with the eye. By pointing at Schwalbe's line, where after they continue as one line down the angle structures and onto the iris. By pointing at Schwalbe's line the corneal wedge locates the top of the trabecular meshwork. Viewing of the corneal wedge is challenging. Its identification is assisted by turning room lights down and ensuring adequate brightness of the slit beam. The beam must be narrow, and the observation and viewing systems of the slit lamp must be offset, but not so much that the two no longer point down the barrel of the goniolens. The corneal wedge is easier to see with Goldmann-type goniolenses because in these the mirror has a relatively low angle of inclination and possesses a better cross-sectional view of the cornea, which in turn can be followed down to locate the wedge. With Zeiss-type goniolenses the tilt of the mirror may be reduced by sliding the goniolens in the direction of the mirror being used. It should be noted that the corneal wedge never appears as obvious as it does in non-photographic representations in textbooks. Owing to the design of slit lamps, it is usually only possible to view the corneal wedge in the superior and inferior angles because decoupling of the illumination and observation systems is only possible horizontally. However, this is normally sufficient to familiarise oneself with the appearance of the angle structures in an individual.

The examination of narrow angles is often difficult because a convex iris obstructs the view of the angle from a mirror located close to the opposite limbus. Owing to their hidden recesses, these angles are susceptible to being misdiagnosed as closed. Disparity or
configuration as it indents maximally centrally and drapes peripherally over anteriorly located ciliary processes.

Angle grading systems

There are numerous systems for grading the anterior chamber angle, each with their virtues and proponents. It is, however, important to appreciate the limitations of reducing complex anatomical relationships to a single figure. It should not be assumed that angles with the same grade are equivalent, or that they have an equal probability of closure.

The most commonly employed grading systems in use today are based on those developed by Shaffer and Spaeth. The Shaffer method simply estimates the angle that the iris makes with the trabecular meshwork and posterior corneal surface in four quadrants. Practically, the angle width is usually determined by the ease at which the various angle structures can be seen, or conversely, by the structures obscured by the iris (Table 1).

The Spaeth system expands on this method and formally assesses other relevant angle characteristics. It sequentially records the level at which the iris apparently inserts (A-E), the geometric angle of iris contact in degrees, the peripheral iris contour (r, s, or q), and the degree of trabecular pigmentation (TMP 1 minimal to 4 very heavy) (Table 2). For example, a Spaeth grading of B−r-TMP 2 refers to an iris that inserts just behind Schwalbe’s line at an angle of 20°, with a regular contour and moderate trabecular pigmentation. Such grading would be typical of a hypermetropic eye with a narrow angle.

Iris

When performing gonioscopy, the contour of the iris plane and its surface should be assessed. A slight convexity of the iris is common. This occurs due to relative pupil block and tends to be greater in hypermetropic eyes. This forward bowing is grossly exaggerated when pupil block is absolute, caused either by primary or secondary mechanisms. Conversely, flat or minimally concave irides may occur in myopia, pseudophakia, and aphakia. Pronounced concavity is often encountered in pigment dispersion syndrome (PDS), where in anatomically predisposed eyes, reverse pupillary block is created when aqueous humour is forced from the posterior chamber into the anterior chamber by the action of blinking.

After surveying the general iris contour, attention should be directed to its angle of approach and the position at which it appears to insert into the ciliary body or other angle structures. A narrow anterior chamber angle is more at risk of angle-closure than one that is widely open. Normally, the angle is narrowest posteriorly and widest inferiorly, possibly bowing is grossly exaggerated when pupil block is absolute, caused either by primary or secondary mechanisms. Conversely, flat or minimally concave irides may occur in myopia, pseudophakia, and aphakia. Pronounced concavity is often encountered in pigment dispersion syndrome (PDS), where in anatomically predisposed eyes, reverse pupillary block is created when aqueous humour is forced from the posterior chamber into the anterior chamber by the action of blinking.

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anterior chamber depth and an iris that remains relatively flat until its periphery, whereupon it sharply turns, draping over anteriorly displaced ciliary processes to create a narrow angle recess.

Blood vessels on the surface of the iris are rarely seen in brown irides, but are relatively common in fair iris colours. Normal iris blood vessels tend to have a relatively thick calibre, and a radial or circular orientation. In contrast, abnormal new blood vessels are finer, lacy, tortuous, and have a random orientation. It is extremely rare to see normal blood vessels crossing the scleral spur to encroach on the trabecular meshwork. Early angle neovascularisation is only rarely cause PAS.

Ciliary body
The ciliary body is most commonly seen as a dull-brown band, although it may appear slate-grey or pink in lighter eyes. Its visibility and width depends on the position of iris insertion. An unusually wide area of ciliary body exposure, particularly when it is irregular or asymmetric, indicates angle-recession. This occurs due to a tear between the longitudinal and circular muscle fibres of the ciliary body following blunt trauma. Although it does not directly cause glaucoma, angle-recession is a marker of concomitant trabecular damage and, by extent, is a significant risk factor for elevated IOP and glaucoma, although this may not occur until years after the original trauma.

Scleral spur
The scleral spur is an internal projection of scleral tissue, identified as a white opaque line that yellows with age. This structure is difficult to see when the angle is narrow, but when visible is of considerable value as a landmark in gonioscopy. Strands of superficial iris tissue often reflect in the angle to extend over the ciliary body to insert into the scleral spur. In light-coloured eyes these iris processes are pale and subtle, and are often mistaken for diffuse illumination. In brown eyes, they are darker and stand out against the scleral spur. Iris processes are generally benign and inconsequential, unless they extend beyond the trabecular meshwork to connect with posterior embryotoxon or iris processes extend over the trabecular meshwork to connect to posterior embryotoxon where they constitute Axenfeld’s anomaly. Iris processes need to be differentiated from PAS, which tend to have a broad base and extend beyond the scleral spur, and functionally inhibit aqueous outflow. PAS with fine points of adhesion can occur following laser trabeculoplasty if the laser is directed too far posteriorly, its energy is too high, or the angle is very narrow.

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**TABLE 1**

<table>
<thead>
<tr>
<th>Shaffer Grade</th>
<th>Angle of approach</th>
<th>Most posterior structure that can be visualised</th>
<th>Interpretation</th>
</tr>
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<tbody>
<tr>
<td>IV</td>
<td>&gt; 35°</td>
<td>Broad band of ciliary body</td>
<td>Incapable of closure</td>
</tr>
<tr>
<td>III</td>
<td>20° &lt; Angle ≤ 35°</td>
<td>Scleral spur or often narrow band of ciliary body</td>
<td>Incapable of closure</td>
</tr>
<tr>
<td>II</td>
<td>10° &lt; Angle ≤ 20°</td>
<td>Posterior trabeculum</td>
<td>Closure possible</td>
</tr>
<tr>
<td>I</td>
<td>0° &lt; Angle ≤ 10°</td>
<td>Schwalbe’s line or possibly anterior trabeculum</td>
<td>High risk of closure</td>
</tr>
<tr>
<td>0</td>
<td>0°</td>
<td>No structures visible. Apex of corneal wedge cannot be visualised</td>
<td>Closed</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>Spaeth classification of iris insertion and iris contour</th>
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<tr>
<td>Iris insertion</td>
</tr>
<tr>
<td>A Anterior to the trabecular meshwork</td>
</tr>
<tr>
<td>B Behind Schwalbe’s line</td>
</tr>
<tr>
<td>C At the scleral spur</td>
</tr>
<tr>
<td>D Deeply – ciliary body visible</td>
</tr>
<tr>
<td>E Extremely deeply</td>
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Trabecular meshwork
The trabecular meshwork extends anteriorly to Schwalbe’s line. Unlike other structures in the angle, scrutiny at high magnification reveals this tissue to have texture and depth. In youth the trabecular meshwork has a translucent blue-grey appearance, but with increasing age it darkens in colour. There is little variation in the degree of pigmentation with race and iris colour, but it is increased in PDS and PXF syndrome, and secondary to inflammation, trauma, ocular surgery, iridocysts and melanomas. Of these, PDS is notable in that its dense pigmentation of the trabecular meshwork is relatively uniform in its distribution around the angle’s circumference, whereas in other aetiologies it is concentrated inferiorly.

Keratic precipitates are occasionally seen on the trabecular meshwork in cases of trabeculitis, most commonly related to Herpes infections or glaucomatocyclitic crisis.

Internal to the trabecular meshwork is the canal of Schlemm, which can only be seen when filled with blood. This does not usually happen because IOP prevents reflux from the venous system. However, reversal of the usual pressure gradient may occur in the setting of ocular hypotony or raised episcleral venous pressure, from either disease or excessive pressure with the wall of the eye and hang, suspended, in the anterior chamber.

Occasionally pigment extends anterior to Schwalbe’s line, patchy and scalloped in appearance, termed a Sampaolesi’s line. This may occur from previous episodes of angle-closure, or any condition that results in pigment release, but most commonly in association with PXF syndrome.

Goniolens disinfection
The Medical Devices Agency advise that wherever practicable, goniolens should be cleaned and disinfected. In this regard, an interesting development is that Haag-Streit have developed a single-use disposable cup (Stery Cup) for some of its lenses.

Guidance on the disinfection of goniolens is published by the Department of Health’s Advisory Committee on Dangerous Pathogens (ACDP). This advice has been strongly influenced by the theoretical risk of transmitting prions from one patient to another, although there are no known cases of transmission of variant Creutzfeldt-Jakob Disease (vCJD) by ophthalmic devices. Until recently the recommended method for decontaminating ophthalmic devices was soaking in sodium chlorite solution providing 20,000ppm of available chlorine for 1 hour. This is more aggressive than disinfection procedures recommended by the leading goniolens manufacturers (Haag-Streit, Ocular-Instruments and Volk), which for sodium hypochlorite suggests either a 0.5 per cent solution for 25 minutes or a 1 per cent solution for 10 minutes. My experience is that Goldmann-type goniolens with mirrors enclosed in a plastic casing can withstand the more aggressive cleaning regime, but some Zeiss-type goniolens do not.

Safeguarding against transmission of disease
Transmission of disease1 is not practicable with goniolens and so they should be cleaned and disinfected. In this regard, an interesting development is that Haag-Streit have developed a single-use disposable cup (Stery Cup) for some of its lenses.

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on whether the clinical benefits of an instrument outweigh the theoretical risks of prion transmission.

Recently the advice for the decontamination of ophthalmic devices by the ACDP ophthalmology sub-group has been updated. It now allows for a lower concentration of sodium hypochlorite of 10,000ppm of available chlorine, and immersion for the shorter time of 10 minutes. This is combined with prior cleaning with soap/detergent and rinsing with water for irrigation (not tap water), and then finally storing the device dry. Soap/detergent is recommended because sodium hypochlorite is not effective against spores and cysts of certain microorganisms. Multiple rinsing is recommended to avoid the accidental damage to subsequent patients with caustic sodium hypochlorite. It is recommended that tap water be avoided to avoid the risk of Acanthamoeba spp. Puzzlingly, this new guidance appears to be inconsistent with another even more recent publication by the ACDP, which continues to state that sodium hypochlorite is considered to be effective at reducing infectivity but only at concentrations of 20,000ppm of available chlorine and when used for at least one hour.

Summary
Gonioscopy is a critical part of the examination of patients with suspected glaucoma and established disease, and on all individuals identified as having possibly closable angles with screening techniques. In addition to the diagnosis and treatment of glaucoma, gonioscopy is often necessary in the diagnosis and management of ocular trauma, inflammation and neoplasia. Besides its functional importance at the business end of aqueous dynamics, no doubt in part due to difficulty in its visualisation, the angle of the anterior chamber is an immensely rewarding and sometimes beautiful part of ocular anatomy to study.

References

Dr Michael Johnson is an optometrist at Bristol Eye Hospital and a research fellow at Bristol University. He has no commercial interest in any product mentioned.