One gonioscopic fallacy

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SUMMARY Traditional gonioscopic practice assumes that, if most of the angle is gonioscopically closed, intraocular pressure increases. Evidence is produced to show that this is fallacious, because at its inception angle closure is iridocorneal contact occurring on the corneal side of the limbus. Although the angle cannot be seen by means of a gonioscope, there is initially no iridotrabecular contact. It is only after pressure increases that iris is pushed against trabecular meshwork and the angle is truly closed.

It is generally accepted by gonioscopists that when 70% of the angle is gonioscopically closed intraocular pressure increases (Becker and Shaffer, 1961; Duke-Elder and Jay, 1969). The purpose of this paper is to show that, and explain why, this is fallacious.

Case history

A woman aged 76 presented with acute closed-angle glaucoma in the right eye. The result of a provocative test in the untreated left eye is recorded in Fig. 1. At zero hour intraocular pressure was 15 mmHg, facility of outflow 0.40 μ l/mmHg per min, pupil diameter 3.3 mm, and gonioscopy revealed an open narrow angle (grade II). Pilocarpine 2% and phenylephrine 10% drops were instilled. One hour later intraocular pressure was 14 mmHg, facility of outflow 0.49, pupil diameter 2.9 mm, and gonioscopy showed the angle to be closed in 30% of its extent. At this point more pilocarpine and phenylephrine drops were instilled. After the lapse of another hour (that is 2 hours from the start of the test) intraocular pressure was 14 mmHg, outflow 0.49, pupil diameter 3.3 mm, and the angle was gonioscopically closed in 80% of its extent. Another drop of phenylephrine was instilled, but thereafter no more drugs were given. Pressure, outflow, and pupil diameter were again measured at 3 and 4 hours from the start, with no significant change in any of these. In addition gonioscopy showed that at least 70% of the angle remained gonioscopically closed.

Discussion

In this patient, therefore, substantial gonioscopic closure of the angle occurred yet there was no

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Fig. 1 Provocative test result in an eye at risk of closed-angle glaucoma. In spite of substantial gonioscopic angle closure, pressure and outflow did not change significantly

P = pilocarpine. T = thymoxamine. F = phenylephrine

increase in pressure, nor did outflow decrease. It is emphasised that this is not a unique case, approximately 30% of eyes at risk of developing closed-angle glaucoma (because the fellow eye has had a spontaneous acute attack) do not produce

Fig. 2 Diagram of an anterior segment with iris bowing forwards towards cornea. Angle narrowness and the presence or absence of closure can be diagnosed either with a gonioscope (position 1) or by noting the distance between iris and cornea internal to the limbus (position 2)

Fig. 3 At its inception angle closure is really irido-corneal contact along a strip on the corneal side of the limbus. Viewed from A (with a slit beam) the angle is closed. From B (with a gonioscope) too the angle cannot be seen and is judged to be closed. However, because of the differing curvatures of iris and cornea and the shape of the angle recess the angle is not truly closed. Moving the slit beam to C shows a gap between iris and cornea

Fig. 4 Because angle closure is initially iridocorneal contact, most of the angle may appear to be closed (gonioscopically), yet pressure may not increase nor outflow decrease. Aqueous can still gain access to all of the trabecular meshwork through the gaps at x and y

a positive provocative test (that is, a pressure increase of at least 8 mmHg with gonioscopic closure). Yet of these 30% substantial gonioscopic closure of the angle does occur on provocative testing in most (70%) (Mapstone, 1977). It is therefore clear that much of the angle can close—gonioscopically—yet pressure does not increase nor outflow decrease. What is the explanation?

There are two possible reasons why pressure did not increase in this patient—either insufficient time elapsed after closure for a significant pressure rise to occur, or gonioscopic closure does not necessarily indicate true angle closure.

The first of these explanations is improbable, because 4 hours had elapsed before the test was

Fig. 5 The angle becomes truly closed only when, as a result of iridocorneal contact, pressure increases. Peripheral iris is now actively pushed on to trabecular meshwork

Fig. 6 Because of the mechanism of initial angle closure a slit beam shone in at 3 will show an open angle. At 2 there is iridocorneal contact throughout most of its length but not at the extremities. However, a beam at 1 will show iridocorneal contact at the extremities but not in the middle

Fig. 7 Photograph of an eye provoked to gonioscopic closure. There is iridocorneal contact throughout most of the length of the slit beam but not at its lower extremity. Note the position of the slit relative to the limbus

Fig. 8 Same as Fig. 7, but the slit has been moved nearer to the limbus. There is a clear gap between iris and cornea

terminated. The second needs examining and implies that currently accepted inferences from gonioscopy are incorrect. The crucial question is, how do angles close? An intuitive analysis follows.

Fig. 2 represents in diagrammatic form an anterior segment with iris bowing forwards towards cornea. Angle narrowness can be assessed either with a gonioscope (position 1) or a slit beam may be shone in on the corneal side of the limbus and the distance between iris and cornea 'measured' in terms of corneal thickness (position 2). In the situation shown the angle is clearly open. Two other points are apparent from Fig. 2. Firstly, the angle is not really a geometric angle at all but a recess, since a finite distance exists between the insertion of iris root into ciliary body and the ciliary body/trabecular meshwork junction. Secondly, the curvature of the anterior iris surface is not the same as that of the cornea.

When, therefore, iris is sufficiently displaced to 'close' the angle (gonioscopically) the situation shown in Fig. 3 obtains. Viewed from position *A* (with a slit beam) there is iridocorneal contact and the angle is closed, from position *B* (with a gonioscope) the angle is also closed. But if the slit beam is moved more towards the limbus (position *C*) the

angle is clearly open, that is, the inception of gonioscopic angle closure is really iridocorneal contact along a strip on the corneal side of the limbus.

If this is a correct interpretation, the situation shown in Fig. 4 will be one possible consequence. If 80% of the angle is gonioscopically closed, aqueous can still gain access to *all* of the trabecular meshwork through *x* and *y*, so that pressure may not increase nor outflow decrease. If the gap between iris and cornea at *x* and *y* is sufficiently narrow, pressure may increase and outflow decrease—but not necessarily enough to produce a 'positive' provocative test. If, however, pressure increases sufficiently, the situation shown in Fig. 5 obtains. An increased pressure now pushes peripheral iris against trabecular meshwork, and the angle becomes truly 'closed'. A vicious circle is generated, and the end result is a positive provocative test or acute closed-angle glaucoma.

The validity of this explanation can be readily demonstrated. Fig. 6 shows that, in an eye provoked to 80% angle closure (but without a pressure increase), if a slit beam is shone in at line 2 there is iridocorneal contact throughout most of its extent, but not at the two extremities. If, however,

Fig. 9 Photograph of an eye, provoked to gonioscopic closure. There is iridocorneal contact throughout the length of the slit beam

Fig. 10 Same as Fig. 9. The slit has been tilted towards the corneal axis. A gap appears between iris and cornea at the middle of the beam (see line 1, Fig. 6)

the slit beam is moved to position 3, the angle is open. Fig. 7 shows an eye provoked to gonioscopic closure (with pilocarpine and phenylephrine). There is iridocorneal contact—except inferiorly—and this has occurred well to the corneal side of the limbus. If the slit beam is now moved nearer to the limbus (Fig. 8), the angle is clearly open.

Fig. 6 also shows that if the slit beam is moved from position 2 (closed) to position 1 there will be iridocorneal contact at the extremities of the beam only. Figs 9 and 10 demonstrate this in a patient.

More than 500 eyes have been provoked to partial or complete angle closure with pilocarpine and

phenylephrine, and the mechanism has always been as described above. It is apparent, therefore, that gonioscopic closure does not necessarily imply true angle closure.

I thank Mrs E. Tubb for secretarial assistance.

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