Diagnostic Tools for Primary Angle Closure

Beyond relative pupillary block—identifying alternative mechanisms for primary angle closure with advanced technology.

BY JASON A. GOLDSMITH, MD, MS

Diagnotic tools for the detection of primary angle closure include old stalwarts such as gonioscopy and slit-lamp estimation of limbal anterior chamber depth as well as new technologies that yield high-resolution, cross-sectional images of the angle. In addition to their diagnostic potential, anterior segment optical coherence tomography (AS-OCT) and ultrasound biomicroscopy (UBM) have provided insight into newly identified mechanisms of primary angle closure that go beyond the effect of relative pupillary block. These etiologic insights may enhance diagnostic accuracy, prognostication, and treatment selection. Other imaging modalities, including Scheimpflug photography and the scanning peripheral anterior chamber depth analyzer, are currently under investigation but do not provide direct images of the angle recess.

GONIOSCOPY, AS-OCT, AND UBM

Gonioscopy is the most comprehensive diagnostic tool for angle closure. It can assess the angle/iris relationship, distinguish between appositional and synechial closure, and provide visualization of the double-hump sign of plateau iris and the vessels of neovascular angle closure. In uncertain diagnoses, gonioscopy can provide visual clues to the presence of pigment dispersion, pseudoexfoliation, and elevated episcleral venous pressure. It is unlikely that novel imaging technology will replace gonioscopy for many of these essential functions.

Gonioscopy, however, is subject to light-induced miosis and inadvertent corneal compression, artifacts that are capable of unintentionally opening the angle. In addition, because gonioscopy can be difficult to master and interpret, its results may be diagnostically uncertain. Gonioscopy is therefore often neglected, potentially resulting in misdiagnosis. For these reasons, among others, alternative imaging technologies are attractive.

The advantages of AS-OCT include that it is noncontact and does not require a highly skilled technician. Upon the identification of the scleral spur with AS-OCT (or UBM)
Various iridocorneal angle parameters can be measured (Figure 2). Potential benefits include efficient population screening in order to identify individuals at risk for angle closure, although this capability remains unproven. AS-OCT cannot penetrate posterior to the iris. UBM, in contrast, penetrates deep enough to image the ciliary body (Figures 1, 3, and 4). The main drawbacks of UBM are that it must be performed by a skilled technician and that direct contact may alter the angle’s width. The benefits of UBM include its utility in identifying nonpupillary block mechanisms for angle closure—mechanisms that may contribute to angle closure in the majority of Asian patients.

Both UBM and AS-OCT can identify narrow and closed angles with reasonable performance. Neither, however, can reliably differentiate between appositional and synechial closure, an essential distinction prior to surgical intervention. As discussed later, the lack of a...
Figure 5. Radial (A) and transverse (B) sections of UBM findings of a 44-year-old female’s eye with acute primary angle-closure glaucoma. IOP was 44 mm Hg at initial examination and was successfully reduced to 12 mm Hg on the next day. Grade 3 uveal effusion (*) was evident as a hypoechographic area between the sclera (S) and the pars plana of the ciliary body (CB) on the next day. Note the angle was still closed. C = cornea; I = iris; L = lens. (Reprinted with permission from Sakai H, Morine-Shinjyo S, Shinzato M, et al. Uveal effusion in primary angle-closure glaucoma. Ophthalmology. 2005;112(3):413-419. ©Elsevier 2005.)

### TABLE 1. CLASSIFICATION SYSTEMS FOR PRIMARY ANGLE CLOSURE

<table>
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<th>AAO Preferred Practice Pattern 13</th>
<th>Research Definition 15</th>
<th>Symptom-Based System 15</th>
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<tr>
<td>Anatomic narrow angle (PAC suspect): the peripheral iris is located close to, but does not touch, the posterior pigmented trabecular meshwork</td>
<td>Primary angle-closure suspect: ITC in three or more quadrants; normal IOP, disc, field; no evidence of PAS</td>
<td>Acute: abrupt onset, symptomatic, elevated IOP that is generally not self-limiting</td>
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<tr>
<td>Primary angle closure: narrow/closed angle plus evidence including elevated IOP, PAS, sector iris atrophy, or glaukomflecken. Can be acute, intermittent, or chronic</td>
<td>Primary angle closure: ITC in three or more quadrants with raised IOP and/or primary PAS. Disc and field are normal</td>
<td>Subacute/intermittent: abrupt onset, symptomatic, elevated IOP that is self-limiting and recurrent</td>
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<tr>
<td>Primary angle-closure glaucoma: PAC plus glaucomatous optic neuropathy</td>
<td>Primary angle closure glaucoma: ITC in three or more quadrants with raised IOP and/or primary PAS, plus disc and field evidence for glaucomatous optic neuropathy</td>
<td>Chronic: elevated IOP or PAS resulting from angle closure that is asymptomatic</td>
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Abbreviations: PAC, primary angle closure; PAS, peripheral anterior synechiae; ITC, iridotrabecular contact.

*Controversy exists with respect to the number of quadrants of ITC necessary to define a PAC suspect, with some physicians advocating as few as one quadrant of ITC.
validated classification system containing a clear case definition for occludable angles prevents predicting which narrow angles are at significant risk of closure. Finally, the identification of the scleral spur can be ambiguous for both UBM and AS-OCT. Without the localization of this landmark, diagnostic uncertainty may remain.6

NONPUPILLARY BLOCK MECHANISMS FOR ANGLE CLOSURE

Nonpupillary block mechanisms include plateau iris, traditionally described as a steep peripheral iris prone to closure and refractory to laser peripheral iridotomy. Plateau iris appears to occur secondary to anterior rotation of the ciliary processes—a UBM finding—which results in butressing of the peripheral iris against the trabecular meshwork (compare Figure 3 to Figure 4). Another UBM finding is the loss of the ciliary sulcus. Other anatomical variants that appear to predispose eyes to nonpupillary block mechanisms include prominent peripheral iris roll and variability in iris insertion.1,4

Another potential nonpupillary block mechanism is uveal effusion, a UBM finding that has been associated with 25% of acute primary angle closure cases in Asian eyes (Figure 5).7 An intriguing hypothesis describes the potential contribution of choroidal expansion and result-

“A primary goal of research on ocular biometry with respect to primary angle closure is the development of a predictive model that forecasts the likelihood of developing angle closure.”

DISCUSSION: CLASSIFICATIONS IN CONTEXT

BY MARC F. LIEBERMAN, MD

In the article by Jason A. Goldsmith, MD, MS, it is interesting to see the three available schemes for classifying angle-closure glaucoma (ACG) in tabular form. One must recognize, however, that these systems are not of equivalent worth and, in fact, are historically sequential.

The "symptom-based" scheme is the oldest. The system was cobbled together from clinical observations made since Curran’s emphasis on “chronic” and “acute” glaucomas in Europe in the 1930s. It was refined by Barkan’s distinction between open- and closed-angle glaucoma, endorsed by the AAO in 1949.1 Except for acute presentations of ACG, the adjectival emphasis on the presumed time course of the condition (eg, “intermittent” or “subacute”) is based on subjective information and is of dubious value. Nevertheless, temporal descriptions have persisted in textbooks until the last decade, qualified by primary and secondary designations and amplified by elaborate descriptions of the pushing and pulling mechanisms underlying the various clinical presentations.2-5

This older nomenclature of chronic and acute ACG (still enshrined in ICD coding) is too imprecise for clinicians or researchers to systematically compare patients, outcomes, or prognoses. In 2005, the authors of the AAO’s Preferred Practice Patterns suggested three categories of (1) narrow angle (vaguely defined), (2) angle closure (still retaining time-based terminology), and (3) frank glaucomatous damage resulting from impaired outflow. Clinicians never widely embraced this classification system, which is handicapped by the absence of parameters for quantifying the extent of trabecular compromise.7

After years of epidemiologic refinement, an international consensus for more robust definitions was reached in 2006 by the Association of International Glaucoma Societies6 and subsequently endorsed by the AAO and other international ophthalmic organizations. Although Dr. Goldsmith refers to these classifications as research definitions, I would contend that they are in fact superbly applicable to clinical management: they are both practical and easy to adapt to the routine care of patients.7
ant posterior pressure to the etiology of angle closure in some cases.8,9

**PREDICTIVE MODELS**

A major goal of research on ocular biometry with respect to primary angle closure is the development of a predictive model that forecasts the likelihood of developing angle closure, thus providing guidance as to when to intervene surgically. Biometric variables that are potentially correlated with the risk for angle closure include anterior chamber depth, axial length, and the lens’ thickness as well as UBM- and OCT-measured angle parameters and the nonpupillary block factors discussed earlier. Future predictive models may also include biometric variables with demographic risk factors (eg, age, race, gender).

Regardless of the exact nature of the predictive test, the most accurate model is one that incorporates into its discriminant function the best set of parameters.10 Only approximately 10% to 25% of untreated primary angle-closure suspects will develop angle closure.9,10 Without reliable prognostic indicators from clinical examination or biometry, it is uncertain which primary angle-closure suspects require treatment. Two large clinical trials of these suspects—one in Guangzhou, China,11 and one in Singapore12—should provide useful information regarding prognostic risk factors, the natural history of untreated eyes, and the efficacy of treatment. These studies have a similar design in which one eye is randomized to laser peripheral iridotomy and the other is followed without treatment.

**CLASSIFICATION SYSTEMS**

The major differences between several available classification systems for primary angle closure (Tables 1 and 2) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s) are whether (1) a suspect is defined by the degree of the angle’s narrowness or by appositional closure, (2) symptoms are considered, and (3) the underlying mechanism(s).
The AAO's Preferred Practice Pattern for Angle Closure advocates a diagnostic scheme that defines primary angle closure suspects as having narrow but not closed angles. The Academy's position is that "laser iridotomy may be considered for patients with narrow angles who require repeated pupil dilation for treatment of other eye disorders." In contrast, a widely used research advocate a diagnostic scheme that defines primary angle closure suspects as having narrow but not closed angles. In contrast, a widely used research advocate a diagnostic scheme that defines primary angle closure suspects as having narrow but not closed angles.

**TABLE 2. PARALLEL CLASSIFICATION OF STAGE AND MECHANISM OF PRIMARY ANGLE CLOSURE**

<table>
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<tr>
<th>Disease staging</th>
<th>Mechanism of closure</th>
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<tr>
<td>Stage 1: Narrow angle (angle-closure suspect)—an anatomical predisposition to closure.</td>
<td>A. Pupil block.</td>
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<tr>
<td>Stage 2: Angle closure—Partial or total closure of the angle with synchiae and /or raised IOP (height and cumulative circumference of PAS should be recorded). (a) Non-isaemic; (b) ischaemic—with tissue injury such as iris whorling or stromal atrophy, often history of symptoms.</td>
<td>B. Anterior non-pupil block—including plateau iris and peripheral iris crowding.</td>
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For angle closure are considered.

**Biometric Parameters**

Much of the research to date on diagnostic tools for primary angle closure has focused on static biometric parameters. Researchers are beginning to recognize that many important parameters are dynamic and subject to physiologic fluctuation, including pupillary dilation and its recently described relationship to iris volume. Specifically, normal eyes have peripheral irides that thin with dilation, but AS-OCT analysis has demonstrated that the iris thins to a lesser degree with dilation in eyes that have primary angle closure. An additional, potential, dynamic physiological factor is choroidal swelling. Future predictive models may include dynamic variables, which may have a greater impact on forecasting the risk for angle closure than the static variables studied to date.

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**References**