Appositional Closure Identified by Ultrasound Biomicroscopy in Population-Based Primary Angle-Closure Glaucoma Suspects: The Liwan Eye Study

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PURPOSE. To describe the characteristics of the iridocorneal angle using ultrasound biomicroscopy (UBM) in Chinese people classified gonioscopically as having suspected primary angle-closure (PACS) glaucoma.

METHODS. PACS were defined as not having visible posterior (usually pigmented) trabecular meshwork in two or more quadrants examined by static gonioscopy. The PACS and 1 of 10 those who did not meet this criterion were identified from a population-based survey. Iridotrabecular meshwork contact (ITC) was identified and further classified into low and high, according to standard UBM images. Those with high ITC were further classified according the configuration of ITC: B-type, with contiguous ITC from the base of the angle, and S-type, with ITC localized to the region of Schwalbe's line.

RESULTS. ITC was identified in 78.6% of the superior, 40.2% of the nasal, 59.8% of the inferior, and 25.6% of the temporal quadrants in the PACS ($n = 117$). These proportions were 43.9%, 15.8%, 29.8%, and 14.0% in the controls ($n = 57$), respectively. About two thirds of the eyes with ITC were classified as high. In those with high ITC, the number with B- and S-type ITC was very similar. The proportions of any high ITCs increased substantially from 15.4% in those with Shaffer angle grade 4 and 45.0% in grade 3, to 71.0% in grade 2, 70.2% in grade 1, and 86.4% in grade 0.

CONCLUSIONS. More ITC is identified on UBM imaging than by gonioscopy. Careful consideration should be given to the assessment modality regarded as the reference standard in defining anatomic risk factors for glaucomatous visual loss and the need for treatment. (*Invest Ophthalmol Vis Sci.* 2011;52:3970–3975) DOI:10.1167/iovs.10-6412

Angle-closure glaucoma is a major ophthalmic problem in China, affecting as many as 4.5 million people, of whom 3.1 million are blind in at least one eye.¹ Iridotrabecular con-

tact (ITC) is the defining characteristic of primary angle closure. The precursor of angle-closure disease, occludable angles, occurs at a rate of 6.4% in Mongolia² and Singapore (age, ≥ 40 years)³ and reached 10% in our population study (age, ≥ 50 years) in Guangzhou, China.⁴ However, longitudinal data suggest that the rate of progression in those with suspected angle closure (persons with occludable angles and no other abnormality) to established angle-closure disease was only 16% in 10 years in Eskimos⁵ and 22% in 5 years in Indians.⁶ Most eyes with high-risk anatomy will not have damage from glaucomatous neuropathy, even over a long period. This highlights the need to identify those who will have visually significant tissue damage from those who will not. However, so far none of the anatomic characteristics linked with the disease have been shown to be good predictors of pathologic angle closure. The geometric width of the iridotrabecular angle on gonioscopy has been shown to correlate significantly with the proportion of people with synechial angle closure, and also with the proportion of people with glaucoma in population-based studies.⁷

Appositional closure represents potentially reversible contact between the peripheral iris and trabecular meshwork (TM). Evidence from a histologic study of trabecular meshwork in angle closure suggests that, in people who have never had an acute episode of angle closure, pathologic changes develop, not only in the areas with peripheral anterior synechiae, but also in those with appositional closure.⁸ This finding suggests that appositional closure is a pathologic sign, for which treatment is indicated, although the finding is still inconclusive and must be replicated.

Gonioscopy remains the standard technique used in the identification of suspected primary angle-closure in both clinical practice and epidemiologic research. However, the designation of an "occludable" angle identified by gonioscopy has, by convention, been determined by the visibility of the posterior trabecular meshwork—first proposed by Arkell et al.^{9,10} In our opinion, that trabecular meshwork is not visible in gonioscopy is not necessarily analogous to an appositional contact. Furthermore, the slit lamp illumination required for gonioscopy may induce pupillary miosis, resulting in apparent opening of the drainage angle. In such cases, appositional closure may not be recognized.^{11,12}

Ultrasound biomicroscopy (UBM), an anterior segment imaging technique, can be performed in near dark conditions. Dark-room UBM has been shown to be useful for detecting appositional closure.¹¹ In this study, we tested the validity of the classification of an occludable angle by examining the association between visibility of TM on gonioscopy and appositional contact, identified by anterior segment imaging.

We also report the proportions of eyes with appositional closure (as determined by UBM in darkness) and the precise anatomic configuration in a group with suspected angle clo-

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sure, as well as a systematically identified group of control subjects on the basis of gonioscopic examinations performed in a population-based survey.

METHODS

Subjects, Gonioscopy, and UBM Examination

Ethical approval was obtained from the Ethics Committee of Zhongshan Ophthalmic Center, and approval was granted by the Research Governance Committee of Moorfields Eye Hospital. The study was conducted in accordance with the tenets of the World Medical Association's Declaration of Helsinki. Examination of the subjects for the cross-sectional survey was performed from September 2003 to February 2004.

Subjects were enrolled from a population-based study conducted for residents aged 50 years and more, using cluster random sampling in the Liwan District, Guangzhou.¹³ Gonioscopy was performed in all participants by a senior ophthalmologist with extensive experience in gonioscopy (HM), using a Goldmann-style one-mirror lens (model 902; Haag Streit, Bern, Switzerland) at a $\times 25$ magnification with low ambient illumination. A narrow vertical beam 1 mm in length was offset vertically for superior and inferior quadrants and horizontally for nasal and temporal quadrants. Care was taken to avoid light falling on the pupil. Slight movement of the lens was allowed, to visualize the drainage angle, but large movements were avoided because of the possibility of indentation. Dynamic examination with a Goldmann lens was performed after static gonioscopy of the four quadrants was completed (alternatively, a four-mirror lens [Carl Zeiss Meditec, Oberkochen, Germany] was used if the indentation by the Goldmann lens was not sufficient). The Spaeth grading system was used for recording the results.^{4,14} The angle width in degrees was recorded for superior and inferior quadrants as similar to Shaffer grades. The angle width was not estimated for all four quadrants, because we found this observation on the nasal and temporal quadrants difficult and most subjective. Apparent iris insertions (depending on the visibility of anatomic landmarks of the drainage angle by static gonioscopy) were recorded for the four quadrants. Interobserver agreement for gonioscopic grading between two of the authors (MGH and PJF) has been reported elsewhere as good to excellent: weighted $\kappa = 0.62$ for angle width, 0.69 for level of apparent iris insertion, and 0.81 for iris profile.¹³

All subjects identified as having suspected primary angle closure (defined by the pigmented trabecular meshwork's being hidden from view in 180° of angle circumference or more, with static gonioscopy in either eye) and 1 of 10 controls (people not meeting the criterion) were invited for UBM examination (P45 ultrasound workstation; Paradigm Medical Industries, Salt Lake City, UT). Any cases with a previous symptomatic episode and established peripheral anterior synechiae with or without glaucomatous neuropathy and those with previous surgery that changed the anterior segment structure (e.g., cataract surgery) were excluded. The UBM examination was conducted in the Zhongshan Ophthalmic Centre (ZOC) main hospital by a technician (XC) who had 8 years' experience in conducting UBM examinations. The technician was masked to the gonioscopic findings. The examination was performed in a dark room with ambient illumination below 5 lux. Images of the four quadrants and 1 image of the central anterior chamber were acquired with the subject supine. The subject was asked to fixate on a ceiling target using the contralateral eye. Five target markers (5 $\times$ 5 cm fluorescent papers) were attached to the ceiling to guide the patients during the measurement of the superior, inferior, nasal, and lateral quadrants, so that the angle between the gaze and the measurement planes would be standardized to 20° and accommodation could be controlled. Saline was used as a coupling agent, and topical anesthesia was administered before the examination. The probe was always perpendicular to the ocular surface. The gain was set between 60 and 80 dB, to have a clear display of the structure and to simultaneously minimize the ultrasound noise. There

were several criteria for acceptable images: clear visualization of the scleral spur, angle, ciliary body, and a half chord of the iris. The tangent line of the anterior surface of the lens was adjusted to be horizontal to ensure that the layouts of the images were standardized.

Identification and Classification of Appositional Closure

All images were exported from the UBM and transferred to a computer for further analysis. If appositional closure existed, the contact was further classified as low and high levels of appositional contact according to the standard photos (Fig. 1). The eyes with high appositional contact were further classified according to the configuration of ITC; B-type, with contiguous ITC from base of the angle, and S-type, with ITC localized to the region of Schwalbe's line with a posteriorly located aqueous-filled sinus (the sinus of Mapstone).¹⁵ All images were graded by the same technician, who was masked to the gonioscopic findings of the subjects.

Statistical Analysis

All analysis was conducted for right eyes only. All cases of established primary angle closure (PAC) or primary angle-closure glaucoma (PACG) and eyes with previous cataract surgery were excluded. Individuals were selected as cases based on gonioscopic findings in either eye. They were then reclassified according to the features in the right eye only. Those eyes meeting the criteria of primary angle closure suspects were cases, the remaining eyes were the controls. The proportion of UBM appositional closure in both cases and controls was calculated and compared by χ^2 test. Logistic regression was used to examine the relation between appositional closure (present in at least one quadrant) and gonioscopic angle width while correcting for the effects of age and sex.

RESULTS

A total of 117 patients with suspected PAC and 57 controls completing the UBM test were eligible and enrolled in the

FIGURE 1. Standard photographs for the classification of presence, height, and type of UBM ITC. (A) No ITC; (B) low ITC; (C) high ITC with B-type (closure starts from the bottom of the angle recess without aqueous filled space); (D) high ITC with S-type (closure occurs at the level of the Schwalbe's line with an aqueous filled space).

TABLE 1. Demographic, Refraction, and Gonioscopy Characteristics of Cases and Controls in Ultrasound Biomicroscopy Study

	Cases* (n = 117)	Controls* (n = 57)	Population Sample (n = 1343)
Age, %†			
50–59	13.7	43.8	35.1
60–69	38.5	29.8	29.2
70–79	42.7	22.8	28.4
80+	5.1	3.5	7.4
Mean (SD)	68.6 (8.0)	63.2 (8.9)	65.0 (10.0)
Sex, %			
M	35.0	43.9	43.9
F	65.0	56.1	56.1
Refraction, %			
< -0.5 D	21.2	29.1	33.7
-0.5 to +2 D	60.6	65.5	59.7
> +2 D	18.3	5.5	6.7
Shaffer angle width			
0	19.0	0	3.9
1	54.3	7.0	10.7
2	22.4	21.0	15.9
3	3.5	28.1	28.9
4	0.9	43.9	40.7

* Cases were subjects with occludable angles (posterior, usually pigmented TM not visible in at least two quadrants) with available UBM data in right eyes; controls were a systematic sample (1 in 10 consecutive) of subjects who did not meet the criterion to be considered a case in the right eye with available UBM data.

† The data are presented as a proportion of the total.

study. Table 1 summarizes the demographic characteristics of cases, controls, and the population survey cohort (after excluding those with previous cataract surgery and glaucoma). The cases were older than the controls (*t*-test, $P < 0.001$). The proportion of women was greater in the cases group, but the difference was not significant (χ^2 test, $P = 0.261$). Cases were more likely to be hyperopic (18.3% of the cases versus 5.5% of the controls, $P = 0.026$). As expected, the cases had a smaller Shaffer angle width (χ^2 test, $P < 0.0001$). When the controls were compared with the population survey cohort, there were no statistically significant differences in terms age, sex, refraction or Shaffer angle width ($P > 0.05$ for all).

Among the PAC suspect cases, ITC was seen in 92 (78.6%) eyes in the superior quadrant, 47 (40.2%) in the nasal, 70 (59.8%) in the inferior, and 30 (25.6%) in the temporal quad-

rants. These proportions were 43.9% (χ^2 test, $P < 0.001$), 15.8% (χ^2 test, $P = 0.001$), 29.8% (χ^2 test, $P < 0.001$), and 14.0% (χ^2 test, $P = 0.082$), respectively, in the control eyes (Table 2). Among the PAC suspect cases, approximately two thirds of the ITC was classified as high, whereas the ratio of high versus low ITC in the controls was similar, although it is acknowledged that the number of subjects was small in each group. The ratio between B- and S-type in those with high ITC was approximately 1:1; this ratio was consistent among the four quadrants in the PAC suspect cases. Similar ratios were found in control eyes except in the inferior quadrant; although again, the small number of available cases may have somewhat affected the reliability of this estimation.

Table 3 compares the number of quadrants with ITC in the PAC suspect and control groups. The distribution of the number of quadrants with low ITC was very similar between PAC suspects and controls (Fisher's exact test, $P = 0.592$). However, the distribution of those with high ITC was considerably different between these two groups (Fisher's exact test, $P < 0.001$). The proportion having high ITC in at least one quadrant was nearly 75% in the PACS group and only 30% in the normal control group.

Table 4 shows the association between Shaffer angle width and appositional closure in one or more quadrants. The rates of low appositional closure did not vary significantly with angle width. However, the rates of high appositional closure were considerably greater in eyes with narrower angles; high appositional closure was seen in 15.4% in Shaffer grade 4 angles, increasing to 70.2% in grade 1 and 86.4% in gonioscopic grade 0 angles. Logistic regression analysis indicated a halving of the likelihood of having high appositional closure with every 10° increase in gonioscopic angle width (adjusted odds ratio [OR], 0.46 [95% confidence interval (CI), 0.33–0.66], controlling for age and sex). This adjusted OR was not significantly different for low appositional closure (adjusted OR, 0.99; 95% CI, 0.75–1.29). Age and sex were both not associated with the existence of any appositional closure after adjustment for the effect of Shaffer angle width.

In this study, the control group (57 eyes) included 48 eyes with pigmented TM visible in all four quadrants and 9 eyes with pigmented TM visible in three quadrants. The findings in those with completely open angles (48 eyes) were similar to those in the control group (Table 3).

TABLE 2. Eyes with ITC in Case and Control Groups Identified by UBM of Right Eyes

Quadrant	Primary Angle-Closure Suspects (n = 117)				Normal Controls (n = 57)			
	High ITC*				High ITC			
	Low ITC*	B-Type†	S-Type†	Any ITC	Low ITC	B-Type†	S-Type†	Any ITC
Superior	28 (23.9)	35 (29.9)	29 (24.8)	92 (78.6)	13 (22.8)	7 (12.3)	5 (8.8)	25 (43.9)
Nasal	12 (10.3)	17 (14.5)	18 (15.4)	47 (40.2)	3 (5.3)	3 (5.3)	3 (5.3)	9 (15.8)
Inferior	16 (13.7)	27 (23.1)	27 (23.1)	70 (59.8)	11 (19.3)	1 (1.8)	5 (8.8)	17 (29.8)
Temporal	10 (8.6)	8 (6.8)	12 (10.3)	30 (25.6)	1 (1.8)	3 (5.3)	4 (7.0)	8 (14.0)

Data are the number of eyes (%).

* Data are presented as proportions of the primary angle-closure suspect and normal control groups. The grading on presence of appositional closure (including low and high) is based on standard photographs.

† Data represent the proportion of B-type (denoting basal contact), characterized as an area of continuous ITC extending from the iris root anteriorly in eyes with appositional closure. This type is differentiated from S-type closure where there is an area of contact between iris and corneal-scleral coat, anterior to an aqueous-filled space separating the peripheral iris and TM (denoting contact at the level of Schwalbe's line). The classification of B- and S-type was made only in those with high ITC.

TABLE 3. Number of Quadrants with Low or High Appositional Closure in Cases and Controls

Quadrants (<i>n</i>)	PAC Suspect Cases <i>n</i> (%)			Normal Controls <i>n</i> (%)			Completely Open-Angle Eyes* <i>n</i> (%)		
	Low ITC	High ITC	Any ITC	Low ITC	High ITC	Any ITC	Low ITC	High ITC	Any ITC
0	68 (58.2)	28 (24.1)	13 (11.2)	38 (66.7)	39 (68.4)	27 (47.4)	31 (64.6)	35 (72.9)	24 (50.0)
1	33 (28.5)	33 (28.5)	27 (23.3)	11 (19.3)	8 (14.0)	12 (21.1)	10 (20.8)	6 (12.5)	10 (20.8)
2	12 (10.3)	33 (28.5)	32 (27.6)	7 (12.3)	7 (12.3)	9 (15.8)	6 (12.5)	5 (10.4)	7 (14.6)
3	3 (2.6)	17 (14.7)	31 (26.7)	1 (1.8)	3 (5.3)	7 (12.3)	1 (2.1)	2 (4.2)	5 (10.4)
4	0	0	13 (11.2)	0	0	2 (3.5)	0	0	2 (4.2)
Total	117 (100)	117 (100)	117 (100)	57 (100)	57 (100)	57 (100)	48 (100)	48 (100)	48 (100)

* Completely open-angle eyes were those with pigmented TM visible in all four quadrants.

DISCUSSION

Gonioscopy remains the reference standard in assessing the anterior chamber angle and for identification of angle-closure disease. Visibility of pigmented (usually posterior) TM during static gonioscopy has been the conventional means of identifying whether an angle is occludable in epidemiologic research.^{9,14} This approach was codified in the ISGEO system for defining glaucoma in epidemiologic research; when the pigmented TM is obscured from view in three or more quadrants using static gonioscopy, the angle is termed occludable.⁹ However, this division is arbitrary, and evidence has been presented suggesting that it may be too stringent.⁷ It is similarly important to realize that “not seeing the TM” does not itself imply physical contact between the iris and TM; rather, it only suggests that the iris is convex to an extent that obscures the visibility of the TM during static gonioscopy.

UBM in the dark is a useful tool for identification of appositional contact between the iris and the cornea-TM. Our study demonstrated, for the first time, a high proportion of low appositional closure in the general population (implying that this is a normal phenomenon), and a graduated dose-related association between the geometric width of the angle (seen gonioscopically) and the high appositional closure seen on UBM. Because the subjects were all enrolled from a population survey, these findings were likely more representative of the community at large than in hospital-based series, where a potential selection bias may overlook some people with narrow angles.

Wilensky et al.¹⁶ empirically proposed that the identification of appositional closure of the drainage angle is the key indicator of an increased risk of clinically significant angle-closure, and was therefore an indication for prophylactic iridectomy and iridotomy. Sihota et al.⁸ reported TM damage identified in a histologic study of trabecular blocks harvested from eyes with angle closure. Further, significant damage to the TM was observed in eyes that had never had an acute episode. The damage was evident in areas with and without peripheral anterior synechiae (PAS). This finding

suggests that appositional closure is not only a sign indicating increased risk of rapid elevation of IOP resulting from angle closure, but also itself could signify a greater risk of pathologic degeneration within the trabecular meshwork. However, in the present study, we demonstrated high rates of appositional closure (as high as 78% in the superior, 60% in the inferior, and 26% in the temporal quadrant) in those with suspected PAC—that is, individuals with no evidence of elevated IOP or PAS. Longitudinal data suggest only approximately 10% to 20% of PAC suspects will develop PAC damage in 5 to 10 years^{5–6,17}. This apparent contradiction suggests that using appositional closure as a sign of clinically significant increased risk may not be appropriate, or at least will lead to a substantial number of false positives.

However, one has to be cautious when attempting to identify appositional closure in UBM images. The location of the TM on UBM images is determined by estimation rather than unequivocal visibility (the TM is usually presumed to be located at a distance of 500 μ m from the scleral spur along the endothelial surface of the cornea).¹⁸ Therefore, the appositional closure identified by UBM may only suggest contact between the peripheral iris and the scleral-corneal coat rather than contact with the TM. This problem will perhaps lead to an overestimation of the proportion of eyes with appositional closure. However, when using the high iridotrabecular contact as an indicator of appositional closure and allowing a more conservative identification of contact between the iris and TM, the proportions were still very high (55% in the superior quadrant in PAC suspects and 20% in the control eyes). This may further support that the contact between TM and the peripheral iris could be much more common than was previously thought. A long-term follow-up of those with appositional closure would be the best way to confirm their risk of developing PAC or PACG.

The variation on image acquisition is another limitation of using UBM to define appositional closure. This variation occurs mainly as a result of inconsistencies in alignment of the UBM probe, failure to control accommodation and room illumina-

TABLE 4. Association of ITC in One or More Quadrant by Shaffer Angle Width in Cases and Controls Combined

Shaffer Angle Width	Low <i>n</i> (%)		High <i>n</i> (%)		Any <i>n</i> (%)	
	Yes	No	Yes	No	Yes	No
0	9 (40.9)	13 (59.1)	19 (86.4)	3 (13.6)	21 (95.5)	1 (4.6)
1	26 (38.8)	41 (61.2)	47 (70.2)	20 (29.9)	57 (85.1)	10 (14.9)
2	15 (39.5)	23 (60.5)	27 (71.0)	11 (29.0)	30 (79.0)	8 (21.0)
3	9 (45.0)	11 (55.0)	9 (45.0)	11 (55.0)	14 (70.0)	6 (30.0)
4	9 (34.6)	17 (65.4)	4 (15.4)	22 (84.6)	11 (42.3)	15 (57.7)

tion, and the unnecessary indentation of the cup. In our study, UBM image acquisition was conducted in a standard dark room with less than 5 lux illumination, and five targets on the ceiling were used to minimize accommodation and standardize gaze direction. Another concern about using UBM images to define angle width is that we took only one cross-sectional image in each quadrant; however, the angle width is estimated in a wider circumference in gonioscopy.

Gorin¹⁹ described the gonioscopic features of the drainage angle in great detail and postulated two kinds of closure: B-type (closure from the bottom of the drainage angle) and S-type (closure that starts from Schwalbe's line). B-type closure is most likely analogous to what was later named "creeping angle-closure" by Lowe²⁰ and is believed to be a mechanism responsible for asymptomatic angle closure. This theory had never been proven because, until the advent of UBM, it was not possible to view by gonioscopy the structures posterior to the site of appositional closure. Our study suggests that B-type closure (at least appositional cases, if not synechial) is not uncommon. About one third of eyes with appositional angle closure have a B-type pattern. This proportion is very similar to that reported in Japan where one third of appositional closure presents as B-type.²¹ Empiric observation suggests that B-type closure mainly develops in eyes with a more anterior insertion of the iris.²¹ However, these features in appositional closure are not always analogous with synechial closure; the transition from appositional closure to synechial closure deserves further longitudinal investigation.

Another important finding is that the proportions of appositional closure in each quadrant decreased in the order of superior, inferior, nasal, then temporal. This order was found to be the same in both the case and control groups. The pattern of variation in appositional closure by quadrants was reported to be in exactly the same order in a recent UBM study of Japanese eyes.²² In this Japanese study, the prevalence of appositional closure in darkness was reported as 79% superior, 64% inferior, 33% nasal, and 26% in the temporal quadrant. These rates are very similar to those seen in our study, although the enrollment criteria for subjects were different: the subjects in the Japanese study were recruited from hospital clinics and identified on the basis of less than one fourth the van Herick grade, after excluding people with PAS. Ishikawa et al.¹¹ reported a slightly lower rate (56%) of appositional closure in 178 Caucasian eyes with Shaffer grade of 1 or 2.

In UBM images, some degree of appositional closure was identified in 79% of subjects with narrow angles and in 44% of control subjects in the superior quadrant. Of note, this disagreement, between gonioscopy and UBM on the detection of angle closure was also demonstrated in a hospital-based study in Singapore, where approximately 59.2% of gonioscopically open-angle eyes were detected as "closed" angle if the anterior segment OCT was used.²³ One reason that appositional closure was seen in control subjects may be the selection criteria: Control subjects were identified according to the amount of posterior pigmented TM that could be seen. If this was visible in less than two complete quadrants, the subjects were classified as primary angle closure suspects. If not, they were eligible as controls. Furthermore, the lighting and inevitable indentation resulting from gonioscopy artificially open the drainage angle, which may be in part responsible for some of the discrepancy between the UBM and gonioscopic classifications. It is also possible that the gonioscopy missed some cases of angle closure, although the gonioscopy was performed by a specialist (MH) who had performed more than 1000 gonioscopic examinations in research settings using the same classification system. In addition, the angle width was graded on superior and inferior quadrants only, whereas we did indeed examine gonio-

scopic characteristics in all four quadrants with the Spaeth system (using the apparent iris insertion as the main outcome for gonioscopic grading). We found the observation on the degree of angle on the nasal and temporal quadrant difficult and most subjective. Thus, we decide to grade the angle width in just the superior and inferior quadrants, and we believe that this method has provided us with sufficiently representative data for analysis.

Our study suggests the probability of observing appositional closure increases from 15.4% and 45.0% in those with Shaffer angle grade 4 and 3, to over 70% in those with grade 2 or less. This dose-response effect suggests that the risk of angle closure increases with the decrease of angle width. Furthermore, the people with Shaffer grades of 2 or less may be at significantly greater risk, as documented in a previous study in which the prevalence of PAC correlated with gonioscopic angle width.⁹ This is consistent with the cutoff values that are traditionally used for the classification of the high-risk population in gonioscopic examination.

In summary, the present study demonstrated a high rate of appositional closure detected using UBM in PAC suspects who had been identified by static gonioscopy on the basis of the number of quadrants with pigmented TM not visible. The disproportionately high rates of appositional closure identified in this study may suggest that further studies on differentiating the appositional contact with increased risk of developing angle-closure damage based on longitudinal observation are needed.

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