Appositional Angle Closure in Chinese With Primary Angle Closure and Primary Angle Closure Glaucoma After Laser Peripheral Iridotomy

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PURPOSE. To determine the prevalence of appositional angle closure (AAC) after laser peripheral iridotomy (LPI) in the eyes of Chinese patients with primary angle closure (PAC) and primary angle closure glaucoma (PACG) and to evaluate its pathogenesis by investigating anatomic characteristics.

METHODS. This was a cross-sectional observational study. PAC and PACG subjects were consecutively enrolled after LPI. Ultrasound biomicroscopy (UBM) images, obtained in darkness, of each quadrant without peripheral anterior synechia (PAS) under gonioscopy were qualitatively assessed. Darkroom provocative test (DRPT) was also performed.

RESULTS. A total of 134 eyes of 134 patients were enrolled. AAC was observed in ≥1 quadrant of UBM image in 85 subjects (63.4%). There were 116 randomly selected quadrants without PAS for 134 patients (86.6%). AAC existed in 38 quadrants (32.8%). Among these, plateau iris accounted for 44.7%, anteriorly inserted iris for 13.2%, thick iris for 13.2%, and anteriorly inserted iris combined with thick iris for 18.4% of the total. One hundred fifteen patients underwent DRPT and its positive rate of eyes with AAC ≥ 2 quadrants (37.5% [12 of 32 patients]) was significantly higher than those ≤ 1 quadrant (16.9% [14 of 83 patients]; P = 0.018). However, no significant differences were found between eyes with nonsynechia plateau iris ≥ 2 quadrants (36.4% [4 of 11 patients]) and those ≤ 1 quadrant (21.2% [22 of 104 patients]; P = 0.266).

CONCLUSIONS. Approximately two-thirds of PAC and PACG eyes of Chinese patients after LPI had AAC. Plateau iris accounted for less than 50% of AAC. Other factors such as a thick peripheral iris and an anteriorly inserted iris also contributed to AAC. DRPT results suggested AAC might have more functional meaning than plateau iris.

Keywords: angle closure glaucoma, appositional angle closure, laser peripheral iridotomy, plateau iris, ultrasound biomicroscopy

Primary angle closure (PAC) and PAC glaucoma (PACG) are highly prevalent in Asia and are responsible for the majority (91%) of cases of bilateral glaucoma-induced blindness in China.1,2 Laser peripheral iridotomy (LPI) is considered the first choice treatment for PAC and PACG, as it eliminates pupil blockage. However, LPI cannot promise well-controlled IOP or prevent progression of PACG.3–5 A recent study found that the rate of unsatisfactory control of IOP was 59.8% and the rate of failure in IOP control was 13.1% in 251 PACG eyes after LPI.3 One explanation for these results may be because LPI relieves only pupil blockage. Nonpupil blockage mechanisms may still play an important role in the formation of peripheral anterior synechia (PAS), thus contributing to an elevation in IOP after LPI.

Appositional angle closure (AAC) is a reversible, nonpermanent irido-angle contact. Eyes in which AAC persists after LPI are more likely to develop PAS, which can lead to angle closure.6 It has been postulated that in Chinese eyes, mixed mechanisms are involved in postiridectomy glaucoma.7 Therefore, we investigated AAC and its anatomic characteristics after LPI in Chinese patients to help understand nonpupil blockage mechanisms in PAC/PACG eyes.

Plateau iris is defined as a flat iris plane with a relatively deeper central anterior chamber and an occludable angle, which can lead to AAC and is considered important in the disease process after LPI.8–10 and has become a crucial topic in the study of nonpupil blockage mechanisms.

In this study, we used ultrasound biomicroscopy (UBM) under dark conditions to determine the prevalence of AAC after LPI in eyes of Chinese patients with PAC and PACG and to study its anatomic characteristics as well as to investigate the relationship between AAC and plateau iris. We also performed a dark room provocative test (DRPT) to detect its functional significance in order to get a better understanding of nonpupil blockage mechanisms in PAC/PACG eyes.

PATIENTS AND METHODS
This was a cross-sectional observational study. Subjects were consecutively enrolled from among patients with PAC or PACG who underwent LPI at the glaucoma clinic of Peking University Third Hospital between January 2009 and December 2009.
PAC was defined according to the following criteria\textsuperscript{11}: an eye with an occludable drainage angle (an angle in which \( \geq 270^\circ \) of the posterior trabecular meshwork could not be seen) and features that indicated trabecular obstruction by the peripheral iris had occurred, such as PAS, elevated IOP, or excessive pigment deposition on the trabecular surface. The optic disc did not have glaucomatous damage. PACG was defined as the presence of glaucomatous optic neuropathy (loss of neuroretinal rim with a vertical cup-to-disc ratio of \( >0.7 \) and/or notching with nerve fiber layer defect that was attributable to glaucoma) with compatible visual field loss, associated with an occludable angle (an angle in which \( \geq 270^\circ \) of the posterior trabecular meshwork could not be seen) and raised IOP and/or PAS.\textsuperscript{11} Approval of this study was obtained from the Ethics Committee Review Board of Peking University Eye Center, Peking University Third Hospital. This study was conducted in strict adherence to the tenets of the World Medical Association’s Declaration of Helsinki. Written informed consent was obtained from each patient enrolled in this study.

Exclusion criteria included (1) cases of secondary angle closure, such as neovascularization of the iris, uveitis, trauma, tumor, lens intumescence or subluxation; (2) eyes that had previously undergone intraocular surgery; (3) subjects unable to tolerate or not suitable for gonioscopy or UBM, for example, those with cornea disease; (4) subjects who did not return for follow-up examinations due to difficult economic conditions and/or who lived distantly; (5) eyes which needed filtering surgery, including those with more than two quadrants of synecchia angle closure according to Chinese Guidelines of Glaucoma Diagnosis and Treatment\textsuperscript{12}; (6) eyes with pupil distortion or iris whirling (distortion of the radially orientated iris fibers) which could affect the evaluation of the angle using UBM; and (7) any other ocular diseases, except for mild cataracts. In the event that both eyes of a patient satisfied the criteria, one eye was randomly selected for our analysis. All enrolled eyes underwent LPI. Approximately 1 to 2 weeks (average: 1.3 weeks) after LPI was performed in their studied eyes, all subjects stopped taking miotic drops for 1 week. Then, all subjects underwent a comprehensive ophthalmic examination that included visual acuity, IOP measurement using a Goldmann applanation tonometer, slit-lamp biomicroscopy, gonioscopy, and ophthalmoscopy.

Static and dynamic gonioscopy were performed in the primary position of gaze under the lowest level of ambient illumination that permitted a view of the angle. Using a static Goldmann single-mirror gonioscopy lens (Ocular Instruments, Bellevue, WA, USA), one of the authors (L-lW), an experienced gonioscopist, observed the anterior chamber angle of the four quadrants: superior, inferior, nasal, and temporal. Compression of the angle was avoided. The angle widths of the four quadrants were graded according to Scheie’s classification system and defined as wide or narrow (grades I–IV); that is, a wide-angle width defined as visualization of the full extent of the trabecular meshwork, scleral spur, and ciliary processes in the primary position; grade I: difficult to see over the iris root into the recess; grade II: ciliary body band was obscured; grade III: posterior trabeculum was obscured; and grade IV: only Schwalbe’s line was visible. Dynamic compression with a Goldmann gonioscopy was used to determine the presence, extension, and height of PAS.

DRPT was performed on all eyes, except for those with IOPs of more than 21 mm Hg (for the safety of patients) and those taking antiglaucoma medication (no matter in the chosen eye or the fellow eye). Senile patients, and those with poorly controlled systemic conditions impairing the tolerance for DRPT also did not receive DRPT. DRPT was performed on subjects that sat in a dark room for one hour and were asked to remain conscious. IOP was measured using a Goldmann tonometer before and after the DRPT. An IOP elevation of 8 mm Hg or more was considered positive.\textsuperscript{13} The observer measuring the IOP was masked to gonioscopic and UBM findings.

All subjects were examined using UBM (Paradigm Medical Industries, Salt Lake City, UT, USA) in darkness (<1 lux, measured with an SF92 luminance meter; Beijing Teachers University Photoelectricity Instrument Factory, Beijing, China). The UBM system was equipped with a 50-MHz transducer, 5.0–5.0-mm field of view, and a spatial resolution of approximately 50 \( \mu \)m (Paradigm Medical). Patients were examined in the supine position. After topical anesthesia was applied, an eye cup containing hydroxyethyl cellulose and physiologic saline was placed on the globe. Then, UBM assessments in the central axis and a 360° radiation scan were performed. Images of the limbal area in the superior (12 o’clock), inferior (6 o’clock), nasal (3 o’clock), and temporal (9 o’clock) quadrants were captured for our analysis.

UBM images of each quadrant were carefully read by three of our authors independently (Y-jY, L-lW, and G-gX). If two of the authors’ opinions were consistent with one another, the final diagnosis was decided. If the opinions were different among all three authors, the three first discussed and then arrived at a mutually agreed diagnosis. Grading was made for each quadrant except for quadrant with PAS in gonioscopy according to the following criteria: PAS-positive quadrant was defined when there was PAS in any position of this quadrant; PAS-negative quadrant was defined when there was no PAS in any position of this quadrant. UBM parameters in PAS-negative quadrant included AAC, plateau iris, thick iris, and anteriorly inserted iris. AAC was diagnosed when the trabecular meshwork and iris were located appositionally on the UBM image (Fig. 1). Plateau iris was defined according to the most recent standard for diagnosing plateau iris, using UBM.\textsuperscript{14} The criteria for defining a plateau iris in any quadrant included the presence of (1) an anteriorly directed ciliary body and an absent ciliary sulcus; (2) a steep iris root from its point of insertion followed by a downward angulation from the corneoscleral wall and the presence of a central flat iris plane; (3) irido-angle contact above the level of sclera spur (Fig. 2). Thick iris was defined according to our own experience. In published reports, iris thickness is usually measured at 500 \( \mu \)m from the sclera spur and is usually less than 0.5 mm, whereas the corneal thickness at the sclera spur is approximately 1 mm, according to our general knowledge. Based on our experience, a thick iris in any quadrant is defined by whether the iris thickness at 500 \( \mu \)m from the scleral spur is \( \geq 2/3 \) of the corneal thickness at the scleral spur (Fig. 3). The classification of an anteriorly inserted iris was based on whether the position of iris insertion was located in 1/3 of the ciliary body near the sclera spur (Fig. 4).

Statistics

All analyses were performed using SPSS 12.0 statistical software (SPSS, Inc., Chicago, IL, USA). Comparisons of age and IOP were performed using a two-tailed standard \( t \)-test. Comparisons of sex, PAC/PACG, and Right/Left were analyzed using two independent sample nonparametric tests (Mann-Whitney \( U \) test). DRPT results, comparisons of AAC and nonsynechia plateau iris in the PAC/PACG groups, were analyzed using the chi squared test and the Fisher exact test. A \( P \) value of \(<0.05\) was considered statistically significant.

Results

There were 295 consecutive PAC/PACG Chinese patients who underwent LPI from January 2009 to December 2009. Of those patients, 150 were excluded due to poor IOP control (who
then needed cataract surgery or filtrating surgery) or for other reasons that impaired following up, such as living far away, impairment due to systemic conditions, low compliance, or some economic factors. The remaining 145 post-LPI eyes of 145 Chinese subjects with PAC and PACG were consecutively enrolled in the study (Table 1). The average IOP of the 145 eyes before LPI was 15.8 ± 7.3 mm Hg (range, 7–57 mm Hg), whereas the average IOP after LPI was 14.9 ± 3.2 mm Hg (range, 8–24 mm Hg). Thirty-six of the 145 eyes (24.8%) had PAS in 1 quadrant, 24 of them (16.6%) had PAS in 2 quadrants, and 85 of them (58.6%) did not have PAS in any quadrant. After excluding subjects with missing (8) or poor quality (3) images, UBM images were available for 134 subjects. There were no differences in age (P = 0.643), sex (P = 1.000), diagnosis (P = 1.000), or post-LPI IOP (P = 0.792) among these subjects (Table 1).

Slit-lamp examination and UBM confirmed that all laser holes in the eyes were open. AAC was observed in at least 1 quadrant of UBM images in 85 eyes (63.4%), and in at least 2 quadrants in 39 eyes (29.1%; “at least 2 quadrants” was the subset of “at least 1 quadrant”). There were no significant differences between the prevalence of AAC in PAC and that in PACG subgroups, in either at least 1 quadrant or at least 2 quadrants (Table 2).

Nonsynechia plateau iris was found in UBM in at least 1 quadrant of 49 subjects (36.6%) and in at least 2 quadrants of 13 subjects (9.7%). No significant differences were found between the PAC and PACG subgroups, either in at least 1 quadrant or at least 2 quadrants (Table 2).

One quadrant of each eye was randomly selected from among the 134 patients according to the random number table. Among the 134 randomly selected quadrants, 18 quadrants were PAS-positive (13.4%), and 116 quadrants (86.6%) were PAS-negative by gonioscopy examination. Among those quadrants without PAS, AAC was found in 38 quadrants (32.8%). Of these 38 AAC-positive quadrants, plateau iris accounted for 44.7% (17 of 38 quadrants), anteriorly inserted iris alone accounted for 13.2% (5 of 38 quadrants), thick iris alone accounted for 13.2% (5 of 38 quadrants), anteriorly inserted iris combined with thick iris accounted for 18.4% (7 of 38 quadrants), ciliary cyst accounted for 2.6% (1 of 38 quadrants), and quadrants exhibiting no obvious reason accounted for 7.9% (3 of 38 quadrants) of the total.

As for the quadrant-based analysis, of the 536 total quadrants from 134 subjects, 77 quadrants (14.4%) were PAS-positive and 459 quadrants (85.6%) were PAS-negative by gonioscopy. Among those PAS-negative quadrants, AAC was found in 143 quadrants (31.2%). Of these 143 quadrants, plateau iris accounted for 42.7% (61 of 143 quadrants),
anteriorly inserted iris alone accounted for 16.1% (23 of 143 quadrants), thick iris alone accounted for 11.1% (16 of 143 quadrants), anteriorly inserted iris combined with thick iris accounted for 20.3% (29 of 143 quadrants), ciliary cyst accounted for 1.4% (2 of 143 quadrants), and quadrants with no obvious reason accounted for 8.4% (12 of 143 quadrants) of the total.

Of the 134 total subjects, 115 subjects underwent DRPT. Nineteen subjects missed DRPT due to the following reasons: Six subjects had an IOP greater than 21 mm Hg, eight subjects were using antiglaucoma medications, and five subjects declined DRPT because of age-related dementia or unwillingness to participate. The average IOP in the 115 eyes before DRPT was $14.7 \pm 3.0$ mm Hg (range, 8–21 mm Hg), whereas after DRPT, the average IOP was $18.9 \pm 4.7$ mm Hg (range, 10–37 mm Hg). The average IOP elevation was $4.5 \pm 3.7$ mm Hg (range, 0–19 mm Hg). A positive DRPT result was found in 26 subjects (22.6%). There were significant differences between

**Figure 3.** Standard view of thick iris under UBM in darkness. (A) Thick iris. Iris thickness shown at 500 µm from the scleral spur was greater than or equal to two-thirds of the corneal thickness at the scleral spur, with iridotrabecular contact. (B) Nonthick iris. Iris thickness shown at 500 µm from the scleral spur was less than two-thirds of the corneal thickness at the scleral spur, without iridotrabecular contact.

**Figure 4.** Standard view of anteriorly inserted iris under UBM in darkness. (A) Anteriorly inserted iris: the position of iris insertion was located in the one-third of the ciliary body near the sclera spur, with iridotrabecular contact. (B) Nonanteriorly inserted iris: the position of iris insertion was located outside the one-third of the ciliary body near the sclera spur, without iridotrabecular contact.
the DRPT of subjects with angle closure (including quadrants with AAC and PAS) $\geq 2$ quadrants and that of subjects with $\leq 1$ quadrant ($P = 0.006$). A similar result was found in the comparison between AAC of $\geq 2$ quadrants and those of $\leq 1$ quadrant ($P = 0.018$). However, there were no significant differences in DRPT for subjects with nonsynechia plateau iris (not including quadrants with PAS; $P = 0.266$) (Table 3).

**DISCUSSION**

Based on our analyses of UBM images, AAC occurred in at least 1 quadrant of 63.4% post-LPI PAC and PACG eyes in darkness. To our knowledge, this is the first study concerning the prevalence of AAC in the eyes of Chinese patients with PAC and PACG after LPI. The high prevalence of AAC after LPI suggests that a nonpupil blockage mechanism plays a significant role in PAC pathogenesis in the Chinese population.

Similarly, Garudadri et al.15 found that in the eyes of Indian patients with PACG, 60% of the eyes (33 of 55 patients) had a narrow angle (angle opening distance $\leq 130\, \mu m$). Our results were also consistent with those of a report by Wang et al.20 in which 38.1% of Chinese eyes had PACG caused by a pupil blockage mechanism, whereas 61.9% were caused by a nonpupil blockage mechanism, although they defined it before patients accepted LPI.

Plateau iris has been widely investigated among nonpupil blockage mechanisms. In plateau iris, anteriorly placed ciliary processes push the peripheral iris against the angle, making it narrow in the presence of a deep central anterior chamber.

In UBM, as a noninvasive tool, has been widely used to observe plateau iris.14,16 However, the diagnostic criteria for plateau iris are not well defined.14,15,17–19 Using their diagnostic criteria in the nonpupil blockage mechanism of angle closure glaucoma. However, whether iris thickness and its position of insertion are, to some extent, associated with the

## TABLE 2. Comparison of Data For Patients Studied

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Eyes Studied, $n =$ 145</th>
<th>Eyes Graded by UBM, $n =$ 134</th>
<th>Eyes Excluded From UBM Grading, $n =$ 11</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean $\pm$ SD age, y (range)</td>
<td>65.8 $\pm$ 9.0 (36–82)</td>
<td>65.7 $\pm$ 8.8 (36–81)</td>
<td>67.0 $\pm$ 11.8 (40–82)</td>
<td>0.643*</td>
</tr>
<tr>
<td>Sex, male/female</td>
<td>38/107</td>
<td>35/99</td>
<td>3/8</td>
<td>1†</td>
</tr>
<tr>
<td>PAC/PACG</td>
<td>119/26</td>
<td>110/24</td>
<td>9/2</td>
<td>1†</td>
</tr>
<tr>
<td>Right/left eye</td>
<td>89/56</td>
<td>81/53</td>
<td>8/3</td>
<td>1†</td>
</tr>
<tr>
<td>Mean $\pm$ SD IOP after LPI, mm Hg (range)</td>
<td>14.9 $\pm$ 3.2 (8–24)</td>
<td>14.9 $\pm$ 3.2 (8–24)</td>
<td>15.2 $\pm$ 3.1 (9–20)</td>
<td>0.792*</td>
</tr>
<tr>
<td>Without eye drops</td>
<td>14.9 $\pm$ 3.2 (8–24) (137 eyes)</td>
<td>14.9 $\pm$ 3.2 (8–24) (126 eyes)</td>
<td>15.2 $\pm$ 3.1 (9–20) (11 eyes)</td>
<td>0.778*</td>
</tr>
<tr>
<td>With eye drops</td>
<td>15.3 $\pm$ 3.7 (9–18) (8 eyes)</td>
<td>15.3 $\pm$ 3.7 (9–18) (8 eyes)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Standard $t$-test.  † Fisher's exact test.

## TABLE 2. Comparison of AAC and Nonsynechia Plateau Iris After LPI of PAC/PACG Eyes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PAC Group</th>
<th>PACG Group</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAC</td>
<td>72/110 (65.4)</td>
<td>13/24 (54.2)</td>
<td>0.298*</td>
</tr>
<tr>
<td>$\geq 1$ quadrant</td>
<td>33/110 (30.0)</td>
<td>6/24 (25.1)</td>
<td>0.625*</td>
</tr>
<tr>
<td>$\geq 2$ quadrants</td>
<td>42/110 (38.2)</td>
<td>7/24 (29.2)</td>
<td>0.406*</td>
</tr>
<tr>
<td>Nonsynechia plateau iris</td>
<td>12/110 (10.9)</td>
<td>1/24 (4.2)</td>
<td>0.462†</td>
</tr>
</tbody>
</table>

* $\chi^2$ test.  † Fisher’s exact test.

32.4% of PACG eyes after patent LPI. We used criteria similar to those of Kumar et al.14,20 and found plateau iris ($\geq 2$ quadrants) in only 9.7% (13 of 134) subjects. This observed difference may be because quadrants with PAS were not excluded for UBM analysis in the studies by Kumar et al.,14,20 which may lead to confusion regarding the identification of plateau iris in UBM images. In our study, UBM images were qualitatively assessed only in quadrants without PAS, using gonioscopy. When analyzing the anatomic characteristics related to AAC, we found plateau iris was accounted for in 44.7% of AAC (17 of 38). In the studies by Kumar et al.,14,20 only the prevalence of the plateau iris was investigated. They did not describe the prevalence of AAC among eyes without plateau iris. In addition to plateau iris, other anatomic factors that cause AAC are also likely to induce PAS.

The more profound results we found were the constitution of the other 55.5% (21 of 38) of the AAC subjects. No reports were found in this area, and our result adds to it. Anteriorly inserted iris alone accounted for 13.2% (5 of 38), thick iris alone accounted for 13.2% (5 of 38), anteriorly inserted iris combined with thick iris accounted for 18.4% (7 of 38), ciliary cyst accounted for 2.6% (1 of 38), and subjects with no obvious reason accounted for 7.9% (3 of 38). Our quadrant-based analysis showed similar results. Although quadrant-based analysis could not exclude correlations within eyes, it provided a general understanding of the constitution of AAC within a larger sample size. Our findings highlight the importance of the position of iris insertion and the thickness of the peripheral iris in the nonpupil blockage mechanism of angle closure glaucoma. Using anterior segment optical coherence tomography, Wang et al.21 also showed that iris thickness was independently associated with narrow angles in their community-based study. Our group also found that a thick peripheral iris was an anatomic characteristic associated with AAC in the fellow eye of Chinese patients with acute PAC.22 It is possible that a thicker peripheral iris crowds the angle, making angle closure more likely to occur. Also, it is possible that as the iris insertion approaches the scleral spur, the peripheral iris is more likely to touch the trabecular meshwork. In our study, we put plateau iris prior to thick iris and anteriorly inserted iris; in other words, plateau iris combined with thick iris or anteriorly inserted iris was classified in the plateau iris group; therefore, the amount of thick iris and anteriorly inserted iris may be more than we reported.

Comparing these anatomic characteristics in normal control eyes with those in eyes with angle closure glaucoma may provide more reliable evidence to support the importance of iris thickness and iris insertion in the formation of angle closure glaucoma. However, whether iris thickness and its position of insertion are, to some extent, associated with the
formation of plateau iris remains unclear. Therefore, further studies are needed to clarify the role thick iris as well as anteriorly inserted iris play in the mechanisms that lead to the formation of plateau iris and angle closure.

In our DRPT results, significant differences were found between subjects with angle closure (including quadrants with AAC and PAS) \( \geq 2 \) quadrants and that in \( \leq 1 \) quadrant. Furthermore, we found eyes with AAC in \( \geq 2 \) quadrants also had significantly higher positive rates of DPRT than those in \( \leq 1 \) quadrant. The similarity in DRPT results may be because in our study average degree of PAS was less than 90°. Although DPRT is typically regarded as being less sensitive than other methods, a recent study showed that post-DPRT IOP was correlated with the extent of functional angle closure detected by anterior segment OCT. Our results were consistent with this finding; however, no such relationship was found between nonsynechia plateau iris and DRPT. The above facts suggest that angle closure or AAC is more closely related with DRPT than plateau iris. Plateau iris may be less important in the progression of angle closure glaucoma than AAC, but we do not deny the importance plateau iris plays in nonpupil blockage mechanism.

We did not find significant differences in prevalence of AAC between the PAC and PACG groups, which is probably due to our small sample size of PACG patients. Nonaka et al. found that the presence of AAC after LPI was much more common after iridotomy in eyes with advanced stages of PACG. Further studies are needed to confirm the precise correlation between AAC and the progression of angle closure glaucoma.

We also found no significant difference in plateau iris between PAC and PACG groups, which may be due to our small sample size of PACG patients. However, Kumar et al. previously found that eyes with PACs (32.3%) had a prevalence of plateau iris similar to that of eyes with PACG (32.4%), which may imply that plateau iris alone is not an independent factor in the progression of angle closure glaucoma.

Our study has several limitations. First, angle closure patients who needed cataract surgery or filtrating surgery were excluded (according to Chinese Guideline of Glaucoma Diagnosis and Treatment, filtration surgery is recommended for eyes with more than two quadrants of synechia angle closure) from this study. It is possible that this specific group of patients has a higher prevalence of AAC, thus there may exist a selection bias. However, surgery or PAS will alter the configuration of anterior chamber and greatly affect the accuracy of UBM grading. Second, we did not compare pre-LPI UBM parameters with post-LPI UBM parameters in this study, which would provide more information and reveal a more interesting and profound result. However we designed this study to investigate the pathogenesis of nonpupil blockage mechanism, in which plateau iris, thick iris, and anteriorly inserted iris were all defined after pupil blockage was relieved by LPI. Therefore, we only analyzed post-LPI UBM parameters. Future analyses are required to supplement this area in the future.

In summary, approximately two-thirds of the Chinese patients with PAC and PACG had AAC, based on UBM findings, in the presence of a patent LPI. This confirmed the nonpupil blockage mechanism in angle closure glaucoma in Chinese patients. Plateau iris accounted for less than 50% of post-LPI AAC. Other factors, such as a thick peripheral iris and an anteriorly inserted iris, contributed more to it. Results from the DRPT imply that AAC might have a more functional role than plateau iris. Thus, apart from plateau iris, we should also pay more attention to other contributing factors causing AAC, such as the position and thickness of the iris. Longitudinal studies are required to determine its clinical significance.

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### References


### Table 3. Comparison of Positive DRPT Results of Angle Closure, AAC, and Nonsynechia Plateau Iris After LPI of PAC/PACG Eyes

<table>
<thead>
<tr>
<th>Parameter*</th>
<th>( \geq 1 ) Quadrant</th>
<th>(&lt; 1 ) Quadrant</th>
<th>( P_1 )</th>
<th>( \geq 2 ) Quadrants</th>
<th>(&lt; 1 ) Quadrants</th>
<th>( P_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle closure (( n/N ))</td>
<td>26.7% (24/90)</td>
<td>8.0% (2/25)</td>
<td>0.059‡</td>
<td>32.8% (20/61)</td>
<td>11.1% (6/54)</td>
<td>0.006†</td>
</tr>
<tr>
<td>AAC (( n/N ))</td>
<td>27.8% (20/72)</td>
<td>14.0% (6/43)</td>
<td>0.086‡</td>
<td>37.5% (12/32)</td>
<td>16.9% (14/83)</td>
<td>0.018†</td>
</tr>
<tr>
<td>Nonsynechia plateau iris (( n/N ))</td>
<td>22.5% (9/40)</td>
<td>22.7% (17/75)</td>
<td>0.984‡</td>
<td>36.4% (4/11)</td>
<td>21.2% (22/104)</td>
<td>0.266‡</td>
</tr>
</tbody>
</table>

* AAC and nonsynechia plateau iris were evaluated by UBM, excluding quadrants with peripheral anterior synechia by gonioscopy. Angle closure included AAC in UBM and peripheral anterior synechia by gonioscopy.

† Chi-square test.
‡ Fisher’s exact test.

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For more detailed information, you can refer to the original source: [http://iovs.arvojournals.org/content/93/3678](http://iovs.arvojournals.org/content/93/3678)