Laser Peripheral Iridotomy in Primary Angle-Closure Suspects: Biometric and Gonioscopic Outcomes

The Liwan Eye Study

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Purpose: To assess the immediate effect of laser peripheral iridotomy (LPI) and mechanisms of angle closure in a population-based study of primary angle closure (PAC) suspects.

Design: Prospective interventional study.

Participants: People identified as PAC suspects aged 50 to 79 years from a population-based survey in Guangzhou, China.

Intervention: Laser peripheral iridotomy was performed in 1 randomly selected eye. Examinations were carried out before and 2 weeks after the intervention.

Main Outcome Measures: Intraocular pressure (IOP), ultrasound biometry, optical pachymetry, and gonioscopy.

Results: A total of 72 people with bilateral suspected PAC participated in the study. Mean IOP decreased by 3 mmHg ($P<0.001$), but axial anterior chamber depth did not change significantly ($P = 0.784$) after LPI. Median limbal anterior chamber depth increased from 15% to 25% of peripheral corneal thickness ($P<0.001$, Wilcoxon signed-rank test). Median iridotrabecular angle width increased from 0° to 10° in the superior quadrant and from 10° to 30° in the inferior quadrant ($P<0.001$). Nevertheless, 14 eyes (19.4%) still had 3 or more quadrants in which the posterior (usually pigmented) trabecular meshwork could not be seen after laser iridotomy.

Conclusions: This study confirms that LPI results in a significant increase in the angle width in Chinese people with narrow angles. However, one fifth of eyes had residual angle closure after LPI. Although this report confirms that iridotomy widens the anterior chamber angle in most PAC suspects, long-term prospective studies with a larger sample size are required to determine if the risks of PAC glaucoma and other related pathologic sequelae are reduced after prophylactic LPI and to investigate the risk-to-benefit ratio before recommending widespread use of prophylactic LPI in this population. *Ophthalmology 2007;114:494–500 © 2007 by the American Academy of Ophthalmology.*

Primary angle closure (PAC) is common among Chinese persons, with an estimated 28.2 million individuals in mainland China being at increased risk of this condition.[1] Although some go on to have PAC glaucoma (PACG), not all do. Determining the optimal approach to identifying and treating people with gonioscopically narrow angles remains a major public health challenge.[2]

Laser peripheral iridotomy (LPI) remains the cornerstone of prophylactic management of angle closure. It results in a significant increase in angle width in both Europeans and

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Asians with narrow angles.[3,4] Laser peripheral iridotomy eliminates relative pupillary block and equalizes the pressures in the posterior and anterior chambers. However, the prophylactic efficacy of LPI for disease control is dependent primarily on the underlying mechanism. In East Asians, mixed mechanism disease (the coexistence of pupil block and nonpupil block) is suggested to be common and important.[5,6] Because patients with nonpupillary block may be less responsive to LPI, it is important to understand how frequently factors other than pupillary block play a role in causing narrow angles. To our knowledge, no data are available to estimate this proportion in unselected PAC suspects identified in the community.

This study examined the immediate impact of LPI on biometry and gonioscopy in Chinese eyes with narrow angles and no evidence of peripheral anterior synechiae, elevated intraocular pressure (IOP), or glaucoma. Follow-up is being continued to assess the prophylactic efficacy and adverse effects of LPI in Chinese people.

Patients and Methods

Patients

Detailed study procedures have been reported previously.[7] In brief, 1405 persons aged 50 years and older were enrolled from Liwan District, Guangzhou, using cluster random sampling. Ethical approval was obtained from the Zhongshan University Ethical Review Board and the Ethical Committee of Zhongshan Ophthalmic Center. The study was conducted in accordance with the tenets of the World Medical Association's Declaration of Helsinki, and all participants signed informed consent for participation. Examination of the participants for the cross-sectional survey was carried out from September 2003 through February 2004.

After registration, the visual acuity was measured using an Early Treatment of Diabetic Retinopathy logarithm of the minimum angle of resolution E chart (Precision Vision, Villa Park, IL) with a standard illumination box at a distance of 4 m. Best-corrected visual acuity was determined using the visual acuity results after autorefraction (ARK-30; Nidek Corp., Gamagori, Japan) with necessary refinement.

A nurse measured IOP with a Tono-Pen (Mentor, Norwell, MA) after instilling topical anesthesia using 0.4% oxybuprocaine hydrochloride (Benoxil, Santen, Osaka, Japan). The internal calibration program was run before use everyday. The measurement was repeated if the standard error (SE) of the measurement was more than 5%. If 3 consecutive measurements were not able to achieve an SE of less than 5% or the patients could not tolerate the test, the IOPs would be considered not measurable (all patients in this cohort had measurable IOP). One measurement was taken and recorded for each eye. The Tono-Pen was chosen after results of previous manometric studies in Singapore demonstrated its greater accuracy in measurement of IOP in Chinese eyes.[8]

Slit-lamp (Model BQ900, Haag-Streit, Bern, Switzerland) gonioscopy then was carried out using a Goldmann-type 1-mirror lens (Model 902, Haag-Streit) at ×25 magnification with low ambient illumination by a single investigator (MH) who was masked to other examination findings. A narrow, vertical beam 1 mm in length was offset horizontally for superior and inferior quadrants and was offset vertically for nasal and temporal quadrants. Care was taken to avoid light falling on the pupil. Small movements of the lens were allowed to visualize the drainage angle, but large movement was avoided because of the possibility of indentation.

Dynamic examination with increased illumination using the Goldmann lens was carried out after static gonioscopy of all 4 quadrants was completed. In cases where the angle structures still could not be visualized clearly, a 4-mirror Zeiss lens (Carl Zeiss Meditec, Oberkochen, Germany) was used. Angle width was estimated in the superior and inferior quadrants as the angle in degrees between a tangent to the surface of the trabecular meshwork and a tangent to the peripheral third of the iris, then was recorded using the Shaffer grading system (0°, 10°, 20°, 30°, or ≥40°).[9] The iris insertion is assessed as: A, anterior to Schwalbe's line; B, behind Schwalbe's line; C, at scleral spur; D, with narrow, visible ciliary body band; or E, very wide visible ciliary body band, according to the grading scheme of Spaeth. The location of contact between the iris and the posterior surface of the cornea before indentation is recorded as the apparent iris insertion, whereas the contact with indentation is recorded as the real iris insertion.[10] In a modification of the Spaeth grading scheme, the iris profile was estimated as steep, plateau, regular, and concave, with the grade chosen to reflect best the entire 360° architecture. Plateau iris profile was specified if the iris rose steeply from its insertion but then made an abrupt angulation away from the corneoscleral wall, resulting in a relatively deep central anterior chamber and a centrally flat iris plane.

Anterior chamber depth (ACD), lens thickness, vitreous length, and axial length of the globe were measured with hand-held A-mode ultrasound (EchoScan US1800; Nidek Corp.) before pupil dilation. In cases where the standard deviations of 10 measurements of ACD were less than 0.13 mm, the single best tracing was selected by the study technician and recorded.

Participants in whom 270° or more of the posterior (usually pigmented) trabecular meshwork was not visible during static gonioscopy were eligible for this study. All patients with established PAC (with evidence of previous acute episode or established peripheral anterior synechiae) or PACG (with established glaucomatous optic neuropathy) were excluded. The definition was based on the International Society of Geographical and Epidemiological Ophthalmology classification system.[11] This report describes cases of primary angle closure, signifying contact between the iris and trabecular meshwork occurring without significant influence of any other pathologic or iatrogenic process. Patients with sudden change in size or position of the lens were excluded, as were patients whose disease was precipitated by aqueous misdirection. Those 80 years of age or older also were excluded because they were unlikely to follow up for the planned duration of this study. Provocative testing was not an enrollment criterion for this treatment. Persons with conditions precluding follow-up (severe health problems, etc.) and those in whom the drainage angle was not clearly visible (because of corneal disease or pterygium) in either eye were excluded. Written informed consent was obtained from all participants before randomization.

Treatment Procedures

Laser peripheral iridotomy was performed with an Abraham lens in the superior region (from 10:00 to 2:00) by a single surgeon (MH) using both argon and yttrium–aluminum–garnet lasers in 1 randomly selected eye. The eye assigned to be treated was determined using sequentially numbered, opaque, and sealed envelopes specifying whether the right or left eye was to be treated. One drop pilocarpine 1% was instilled into the intervention eye 15 minutes before treatment. The argon laser was used starting at settings of 500 mW, increasing up to 1000 mW according to the tissue response, with a spot size of 50 μm for a duration of 0.1 to 0.3 seconds. As soon as the iris thinned to the point where there was

Table 1. Characteristics of Participants and Those Who Declined Laser Peripheral Iridotomy*

	Participants† (n = 72)	Declined to Participate† (n = 29)	Response (%)	P Value‡
Age (yrs)				
50–59	13 (17.6)	2 (5.9)	86.7	0.313
60–69	27 (36.5)	14 (36.4)	65.9	
70–79	32 (43.2)	13 (28.9)	71.1	
Gender				
Male	20 (27.8)	11 (37.9)	64.5	0.317
Female	52 (72.2)	18 (62.1)	74.3	
IOP				
Mean	14.4	14.8	—	0.135
SD	3.0	3.0	—	
ACD				
Mean	2.05	2.08	—	0.241
SD	0.17	0.22	—	
Shaffer grade§				
Mean	0.6	0.6	—	0.798
SD	0.3	0.5	—	

ACD = anterior chamber depth; IOP = intraocular pressure; SD = standard deviation.
*The cases are occludable angles after excluding those with diagnosis of primary angle closure or primary angle closure glaucoma in either eye.
†Data in parentheses are proportions by column.
‡*P* value is given by chi-square test for age and gender and by Student's *t* test for IOP, ACD, and Shaffer grading. The right eye in the declined-to-participate group was chosen for the comparison.
§Mean of Shaffer grades of superior and inferior quadrants.

a honeycomblike appearance, the neodymium:yttrium–aluminum–garnet laser was used starting at an initial setting of 2 mJ and then increased up to 6 mJ until the iris was fully perforated and an iridotomy of approximately 0.3 mm was achieved. Full-thickness perforation was confirmed when aqueous came forward from the posterior chamber to the anterior chamber with dispersion of pigment. The baseline IOP, number of laser applications, and energy settings were recorded. Individuals who had an IOP rise of <5 mmHg 1 hour after the treatment were discharged; otherwise, patients were given a topical carbonic anhydrase inhibitor (dorzolamide) and 0.5% timolol and the IOP was rechecked 1 hour later. If no further rise was seen in the second hour, the patients were discharged. All patients were given 1% dexamethasone drops to apply 4 times daily for 1 week. Pilocarpine was not used after the treatment. At least 2 weeks (range, 14–17 days) after the LPI treatment, the patients returned for a postoperative examination. These examinations included: visual acuity, IOP, gonioscopy, ultrasound ocular biometry, optical pachymetry, and ultrasound biomicroscopy (UBM). Both slit lamp and UBM evaluations were used to confirm patency of the iridotomy.

Results

A total of 101 persons with occludable angles in both eyes were considered to be eligible for the study and were offered laser iridotomy, 72 of whom (71.3%) participated (38 right and 34 left eyes). The major reason for nonparticipation among otherwise eligible participants was the decline of consent. There was no difference between participants and nonparticipants in terms of age, gender, baseline IOP, ACD, and angle width (Table 1).

The iridotomy was patent in all but 1 eye after a single treatment session. The size of the iridotomy was approximately 0.2 to 0.3 mm in all patients. In the 1 patient in whom the iridotomy was not fully patent at the initial follow-up examination, a repeat laser successfully created an iridotomy, and data were collected 2 weeks afterward the repeated procedure.

An immediate pressure spike (IOP elevation of 5 mmHg or more 1 hour after LPI) was observed in 14 eyes (19.4%). Intraocular pressure elevation was 5 to 9 mmHg in 7 eyes and 10 to 17 mmHg in another 7 eyes. All patients with IOP elevation were treated with dorzolamide and 0.5% timolol and the IOPs had no further elevation after 2 hours.

The mean IOP of the enrolled participants before LPI treatment was slightly lower than for the larger population studied, but this difference was not statistically significant (after excluding the patients with PACG, 14.3 mmHg vs. 15.1 mmHg, respectively; $P = 0.124$). After LPI, the IOP decreased by an average of 3 mmHg ($P<0.0001$, paired *t* test) in treated eyes at 2 weeks (Table 2). The mean axial ACD measured by optical pachymetry did not change after LPI (2.05 mm before vs. 2.04 mm after treatment; $P = 0.784$, paired *t* test). Axial length and lens thickness were unchanged as well ($P>0.05$).

Limbal ACD (LACD) increased significantly after LPI (Table 3). All patients had an LACD of one fourth or less of corneal thickness (traditional van Herick grade ≤2) before LPI, and this proportion decreased to 67% after laser treatment. Although 77.1% of treated eyes had an increase in LACD, only 7.1% had a decrease. Median LACD increased from 15% to 25% of peripheral corneal thickness after treatment ($P<0.0001$, Wilcoxon signed-rank test).

The agreement of gonioscopic examination between the study gonioscopist (MH) and another experienced examiner (PJF) was assessed based on masked grading of 28 eyes of 28 patients. Weighted κ values for Shaffer grades of superior and inferior

Table 2. Intraocular Pressure and Biometric Changes before and after Laser Peripheral Iridotomy

	n*	Mean before Laser Peripheral Iridotomy (95% Confidence Interval)	Mean after Laser Peripheral Iridotomy (95% Confidence Interval)†	Mean Change
IOP (mmHg)	72	14.4 (13.7–15.1)	11.3 (10.6–11.9)	3.1‡
ACD (mm)§	71	2.05 (2.01–2.09)	2.04 (1.97–2.12)	−0.008
Lens thickness (mm)‖	72	4.70 (4.51–4.89)	4.80 (4.70–4.90)	0.10
Axial length (mm)‖	72	22.50 (22.28–22.71)	22.47 (22.27–22.67)	−0.03

ACD = anterior chamber depth; IOP = intraocular pressure; SD = standard deviation.
*Number of available records. Data on ACD is missing for 1 participant.
†Without using medication influencing IOP for 2 weeks.
‡$P<0.001$.
§Measured by optical pachymetry.
‖Measured by ultrasound biometry.

Table 3. Limbus Anterior Chamber Depth Grading before and after Laser Peripheral Iridotomy*

Limbus Anterior Chamber Depth before Laser Peripheral Iridotomy	Limbus Anterior Chamber Depth after Laser Peripheral Iridotomy						
	5%	*15%*	*25%*	*40%*	*75%*	*100%*	*Total*†
5%	4 (11.8%)	12 (35.3%)	12 (35.3%)	4 (11.8%)	2 (5.9%)	0 (0%)	34 (100%)
15%	0 (0%)	5 (20.8%)	7 (29.2%)	4 (16.7%)	6 (25.0%)	2 (8.3%)	24 (100%)
25%	3 (25.0%)	2 (16.7%)	2 (16.7%)	2 (16.7%)	3 (25.0%)	0 (0%)	12 (100%)
40%	0	0	0	0	0	0	0
75%	0	0	0	0	0	0	0
100%	0	0	0	0	0	0	0
Total	7	19	21	10	11	2	70†

*$P<0.0001$ (Wilcoxon signed-rank test), indicating wider limbus anterior chamber depth after laser peripheral iridotomy.
†Limbus anterior chamber depth data are missing in 2 subjects.

quadrants were 0.63 (SE, 0.18) and 0.62 (SE, 0.25), respectively. The κ values for the Spaeth apparent iris insertion grading on superior, inferior, nasal, and temporal quadrants were 0.69 (SE, 0.24), 0.84 (SE, 0.37), 0.71 (SE, 0.35), and 0.77 (SE, 0.29), respectively. κ values for iris profile were found to be 0.81 for steep, 0.93 regular, and 0.71 for plateau profile, whereas no patient with a concave profile in this small group of participants allowed the evaluation. Because of the low number of persons with narrow angles in the initial standardization, we repeated the comparison in laser iridotomy-treated and untreated eyes, with a weighted κ of 0.82 for the determination of narrow angles in 44 eyes.

The Shaffer angle width increased significantly in both superior and inferior quadrants ($P<0.0001$, Wilcoxon signed-rank test). In the superior quadrant, the median Shaffer grade increased from 0 to 1. Shaffer grade increased in 50 eyes (72.4%), remained unchanged in 14 eyes (20.3%), and decreased in only 5 eyes (7.2%). Similar findings were observed in the inferior quadrant (Table 4). After LPI, the proportion of eyes graded A or B for apparent iris insertion decreased from 98.5% to 61.4% in the superior quadrant, from 75.7% to 28.6% nasally, from 57.1% to 17.1% in the inferior quadrant, and from 85.7% to 21.4% temporally (Table 5). With the exception of the superior quadrant, more than 80% of angles with an apparent iris insertion grade A to B converted to grade C or D after the LPI procedure. These changes before and after LPI were significant in all quadrants ($P<0.0001$, Wilcoxon signed-rank test).

Before LPI, gonioscopic iris profiles were graded as steep in 46 eyes (66.7%) and as plateau in 23 eyes (33.3%). Among the 46 eyes with a steep iris profile, 39 eyes (84.8%) were no longer steep after LPI, whereas among those graded as plateau at baseline, 15 (65%) converted to a regular profile after LPI.

After LPI, 14 eyes (19.4%) persisted in having 3 or more quadrants in which the posterior, pigmented trabecular meshwork could not be visualized using gonioscopy in primary gaze without the use of compression. Although these persons tended to be

Table 4. Shaffer Angle Width before and after Laser Peripheral Iridotomy

Shaffer Grade before Laser Peripheral Iridotomy	Shaffer Grades after Laser Peripheral Iridotomy					
	0	*1*	*2*	*3*	*4*	*Total**
Superior quadrant* grades						
0	10	11	6	12	7	46
1	4	4	3	8	2	21
2	0	0	0	1	0	1
3	0	1	0	0	0	1
4	0	0	0	0	0	0
Total	14	16	9	21	9	69
Inferior quadrant grades†						
0	2	2	4	9	4	21
1	1	0	9	17	8	35
2	0	0	1	6	4	11
3	0	0	1	0	1	2
4	0	0	0	0	0	0
Total	3	2	15	32	17	69

*Postoperative data were not available in 3 eyes: 1 because of acute conjunctivitis, two because of incomplete examination.
†$P<0.0001$ (Wilcoxon signed-rank test), indicating wider Shaffer grades after laser peripheral iridotomy.

Table 5. Apparent Iris Insertion before and after Laser Peripheral Iridotomy*

Iris Insertion before Laser Peripheral Iridotomy	Apparent Iris Insertion after Laser Peripheral Iridotomy†					
	A	*B*	*C*	*D*	*E*	*Total*‡
Superior quadrant before LPI						
A	2	14	7	3	0	26
B	3	24	15	1	0	43
C	0	0	1	0	0	1
Total	5	38	23	4	0	70
Nasal quadrant before LPI						
A	0	2	5	0	0	7
B	0	15	27	4	0	46
C	0	3	8	6	0	17
Total	0	20	40	10	0	70
Inferior quadrant before LPI						
A	0	3	2	2	0	7
B	1	3	24	5	0	33
C	0	5	20	4	1	30
Total	1	11	46	11	1	70
Temporal quadrant before LPI						
A	0	2	4	2	0	8
B	0	12	32	7	1	52
C	0	1	9	0	0	10
Total	0	15	45	9	1	70

LPI = laser peripheral iridotomy.
*$P<0.0001$ (Wilcoxon signed-rank test for all quadrants), indicating deeper iris insertion after LPI.
†Grade based on iris insertion on Spaeth grading system using static gonioscopy: A, anterior to Schwalbe's line; B, behind Schwalbe's line; C, at scleral spur; D, deep into the ciliary body; E, extremely deep into the ciliary body.
‡Data of iris insertion are missing in 2 cases.

younger and male, these associations were not statistically significant. The IOP reduction in the eyes with residual closure was slightly less (2.7 mmHg; SE, 0.8) than that recorded in the 80% of eyes with open angles after LPI (3.1 mmHg; SE, 0.4), but this difference was not statistically significant ($P = 0.725$). The ACD for these persons at baseline measured by optical pachymetry was similar to that of those who were open after LPI (2.04 mm in eyes with open angles vs. 2.08 mm in those remaining closed; $P = 0.477$).

Discussion

Laser peripheral iridotomy is the standard first-line intervention for acute and chronic angle closure.[3] It prevents recurrence of acute episodes and eliminates the risk of acute attacks in fellow eyes.[4,12–15] By allowing aqueous to flow directly through the iridotomy site, LPI equilibrates the pressure between the anterior and posterior chambers. Eliminating this pressure gradient flattens the iris, allowing the peripheral iris to fall backward, resulting in a wider angle configuration. We found this to be the case, with 85% of those with steep iris configuration at baseline having a regular configuration after LPI. Interestingly, even those believed to have a plateau configuration on gonioscopy at baseline had a high likelihood of having a regular configuration after LPI (65%), indicating that pupillary block contributes to the gonioscopic appearance in these patients.

We confirmed previous findings that LPI does not affect axial ACD in persons with narrow angles on gonioscopy.[13,16–18] In contrast, anterior chamber angle width changes were substantial in this population. There was an overall increase of 2 units in Shaffer angle grade (approximating to an increase in iridotrabecular angle of 20°) after LPI. This is similar in magnitude to that reported for a Mongolian population-based intervention study (median, 2-grade increase).[19] A lesser increase was reported in fellow eyes of those with PACG (mean, 0.8-grade increase),[16] which may indicate that these eyes, which are predisposed to symptomatic angle closure, behave differently in response to LPI. Further research is needed to confirm this difference. Widening of the drainage angle also has been documented by others, although less quantitative methods were used.[20,21]

Although the finding that LPI increases angle width is consistent across the literature, observer bias cannot be excluded as a possible explanation for this finding. Shaffer gonioscopic grading is subjective, and it is impossible to mask the gonioscopist completely to the presence of an LPI. However, the consistency and the magnitude of the findings tend to confirm that the anterior chamber angle widens after LPI in most treated eyes. Importantly, the angle remains closed in one fifth of Chinese people undergoing LPI. Whether this leads to worse outcomes in these individuals requires additional follow-up of this and similar cohorts.

Without any ocular hypotensive medication use, the IOP decreased by almost 3 mmHg after LPI. Although reduction in IOP has been recorded previously after LPI in persons with PAC and elevated baseline IOP in Europeans[4,22] and Asians,[19,23] previous reports have not looked at the short-term impact of LPI on IOP in PAC suspects. Our finding of short-term IOP reduction is consistent with a study conducted in hospital-based patients with occludable angles in Taiwan: IOP was found to decrease from 14.0±3.6 mmHg to 11.7±2.8 mmHg 6 months after LPI.[20] Krupin et al reported an IOP increase from 17.4±3.4 mmHg to 23.5±10.3 mmHg at 1 to 2 hours and then a decrease to 16.4±3.9 mmHg at 24 hours in European eyes.[24] Circumstantial evidence supports a possible pressure-lowering effect of LPI. Using cross-sectional data from Singapore, Foster et al[25] found that for every 10° difference in angle width, mean IOP decreased by 0.2 mmHg on average. The authors hypothesized that this lower IOP in wider angles may be the result of greater tension on the trabecular beams, resulting in wider pores and increasing outflow. This hypothesis is supported by evidence of a fall in IOP after cataract surgery[26] and pilocarpine treatment.[27] Another possible explanation for the decline in IOP seen in this study at 2 weeks is an ongoing effect of IOP lowering from medications applied at the time of LPI. However in this series, only 14 patients received timolol, dorzolamide, or both at the time of LPI because of an IOP elevation. Excluding these patients from the analysis did not alter the magnitude of the IOP decrease (14.7 mmHg before vs. 11.3 mmHg after treatment). The pilocarpine given to all patients in this study before LPI would not be expected to affect the IOP 2 weeks after administration. Other explanations for this relatively large amount of short-term IOP lowering could be ongoing intraocular inflammation leading to a prostaglandinlike effect on outflow or activation of trabecular meshwork cells, similar to that believed to occur after laser trabeculoplasty. Long-term follow-up is required to see if the IOP-lowering effect persists.

Understanding the proportion of angle-closure patients and suspects in whom the pupillary block is the cardinal mechanism responsible for closure is of paramount importance from the public health perspective. Prophylactic laser iridotomy may be less effective in eyes where pupillary block is one of several mechanisms causing angle closure. It is not clear that LPI is sufficient for PAC suspects in whom nonpupillary block mechanisms are a major contributing factor.

In the current study, the gonioscopic designation of residual angle closure after laser iridotomy was used to identify a nonpupillary block mechanism. This definition is arbitrary rather than evidence based and requires an assumption that those eyes with residual narrowing drainage angles are predominated by a nonpupillary block mechanism. This leaves room for the possibility that the LPI is still able to prevent the onset of glaucoma even though the drainage angle remains closed after LPI. Approximately one fifth of eyes continued to have gonioscopic appositional angle closure after LPI in this study. This finding suggests that these individuals may have factors other than pupillary block that play a role in closing the angle. Anterior rotation of the ciliary body and a thick peripheral iris roll are 2 possible mechanisms that may lead to post-LPI appositional closure. The lens also may be a physical cause of angle closure in some of these individuals. Others have reported nonpupillary block mechanisms in Chinese persons. In a hospital-based study, Wang et al[6] found that 8% of 126

Chinese PACG patients (a mixture of PAC suspects, PAC patients, PACG patients, and acute angle closure patients) had UBM features that were consistent with these other possible mechanisms before and after iridotomy. The authors believed that these other factors played a role in more than half of the cases of angle closure, but identified pupillary block as also playing a contributory role. The UBM features used by the authors in this study to classify the mechanisms include iris convexity (bombé), anterior iris insertion, extensive iris–lens contact, a thick peripheral iris, and anterior rotation of the ciliary body. These observations are subjective, however, and it is difficult to be certain which factors are responsible for angle closure in these patients. In the present study, we documented that eradicating pupillary block results in significant angle widening in more than 80% of Chinese people with narrow angles identified by screening people in a community setting who showed no evidence of glaucoma (i.e., PAC suspects). This indicates that the iridotrabecular contact observed in these people was caused by pupillary block.

Researchers have attempted to define postiridectomy angle closure by using the darkroom prone provocative test (DPPT) to elicit a rise in IOP in patients who have undergone LPI.[28] Using this approach, one group reported positive DPPT results (pressure rise of ≥8 mmHg) in 60% of patients after iridotomy (the study population included patients with PAC having less than 120° of peripheral anterior synechiae) versus 2.5% of healthy persons with open angles. Much lower rates of DPPT positive results have been reported in the eyes of white persons.[29] Although some have argued that positive DPPT results after LPI indicates that nonpupillary block mechanisms are responsible for the angle closure, we believe that more research is needed to prove that these pressure rises are the consequence of iridotrabecular contact. The DPPT was not predictive of outcome in 1 large study of the prophylactic efficacy of LPI in PAC suspects.[30]

One finding of great clinical relevance was that, in those people we identified as having a plateau iris configuration (23 eyes), angle width increased after LPI in most (19 eyes). The importance of drawing a clear division between plateau iris configuration and plateau iris syndrome was emphasized previously.[31] Our findings emphasize that a plateau iris configuration may be alleviated by LPI. This in turn emphasizes that dynamic gonioscopy may help to predict which eyes will and will not respond to LPI. However, we see no reason not to recommend a change from current practice of performing an LPI as the first intervention in patients with angle closure. Ultimately, prospective follow-up of patients with eyes that remain gonioscopically closed after LPI is required to determine if these persons are at increased risk of a poor outcome.

In summary, we documented that among a cohort of Chinese PAC suspects recruited from the community, LPI resulted in a substantial increase in angle width. However, one fifth continued to have 270° or more of appositional closure after this treatment. A long-term follow-up of this cohort of patients is required to have a better understanding of the natural history of angle closure and to confirm the risk-to-benefit ratio of LPI for the prevention of PACG in people with narrow angles.

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