

CHINESE MEDICAL SCIENCES JOURNAL

ORIGINAL ARTICLE

Gonioscopy and Ultrasound Biomicroscopy in the Detection of Angle Closure in Patients with Shallow Anterior Chamber[△]

Shan-shan Cui¹, Yan-hong Zou^{1*}, Qian Li^{1,2}, Li-na Li¹,
Ning Zhang¹, and Xi-pu Liu^{1,3}

¹Department of Ophthalmology, First Hospital of Tsinghua University, Beijing 100016, China

²Medical Center Tsinghua University, Beijing 100084, China

³Department of Ophthalmology, Sekwa Eye Hospital, Beijing 100088, China

Key words: gonioscopy; ultrasound biomicroscopy; angle closure glaucoma

Objective To assess the agreement between gonioscopy and ultrasound biomicroscopy (UBM) in detecting angle closure in Chinese patients with shallow anterior chamber.

Methods An observational comparative study of the two different examination methods was conducted. Patients with normal intraocular pressure and temporal peripheral anterior chamber depth less than a quarter of corneal thickness based on slit lamp examination were included in this study from December 2007 to May 2009 in the outpatient clinic of First Hospital of Tsinghua University. Gonioscopy was performed with a Goldman gonioscope in dark room first and followed by full beam light and indentation. If the filtering trabecular meshwork was invisible or any peripheral anterior synechia was found, that quadrant of the angle was considered closed. UBM was first undertaken in a darkened room then repeated with normal room lighting. If iridotrabecular apposition was showed, that quadrant of the angle was considered closed. The status of angle closure of each quadrant with different methods was recorded.

Results 85 eyes of 46 patients were included in this study. The agreement between gonioscopy and UBM was poor ($\kappa < 0.4$) with Kappa analysis in both dark and light conditions in each quadrant. The accordance of agreement between gonioscopy and UBM was hardly affected by age or sex, while in dark condition, eyes with deeper anterior chamber ($P=0.005$) or plateau iris configuration tended to produce different results ($P=0.075$) in the 2 methods.

Conclusion Gonioscopy and UBM are both indispensable methods for detecting angle closure, neither can completely replace the other.

Chin Med Sci J 2014; 29(4):204-207

PRIMARY angle-closure glaucoma (PACG) is the leading cause of blindness worldwide, especially in East Asia.¹⁻³ Shallow anterior chamber and narrow angle as determined by limbal chamber depth grading has been reported as the main risk factor identified for the development of occludable angle.⁴⁻⁶ If angle closure can be detected early, it is possible to prevent further development of the disease with laser peripheral iridotomy and, when necessary, laser peripheral iridoplasty.⁷

The current standard technique for anterior chamber angle assessment is gonioscopy, which relies on real-time subjective assessment and is rather difficult for beginners to perform. According to a survey conducted in a Chinese national conference on glaucoma in 2005, about 19% of the participant professionals did not apply gonioscopy as a standard diagnostic method of angle closure glaucoma.⁸ An alternative method to assess the anterior chamber angle is ultrasound biomicroscopy (UBM), which may provide insight into the angle configuration.⁹ In the same survey mentioned above, over 49% of the participants reported to use UBM to screen for angle closure.⁸

Given the high prevalence of shallow anterior chamber in China,^{10,11} a convenient and accurate method is needed in screening angle closure in people at high risk. Taking into consideration the fact that only part of ophthalmologists applied gonioscopy, we propose the application of UBM in place of gonioscopy in early detection of angle closure. As the crucial evidence supporting our hypothesis, the agreement between gonioscopy and UBM is evaluated in patients with shallow anterior chamber in the present study.

PATIENTS AND METHODS

Study subjects

From December 2007 to May 2009, persons with normal intraocular pressure and temporal peripheral anterior chamber depth less than a quarter of corneal thickness based on slit lamp examination using the van Herick technique⁹ were invited to receive further examination in the outpatient clinic of First Hospital of Tsinghua University. Patients with a history of trauma or glaucoma, or a history of previous incisional or laser surgery were excluded. The study was approved by the Ethics Committee of First Hospital of Tsinghua University and conducted in accordance with the principles outlined in the Declaration of Helsinki involving human subjects. Informed consent was obtained from each participant.

Examination procedures

Gonioscopy was performed by a single examiner (Yan-hong Zou) with the patient seated, using a Goldmann goniolens in a dark room, first using a 1-mm-length beam that did not fall upon the pupil (dim illumination) followed by full beam light and indentation (light condition). If the filtering trabecular meshwork was invisible or any peripheral anterior synechia was found, that quadrant of the angle was considered as closed.

Enrolled participants underwent imaging with an ultrasound biomicroscope (Suwei SW-3200, Tianjin Suwei Electronic Technology Co., Ltd., China) using an immersion technique and a 50-MHz transducer, first in dark condition then repeated in normal room lighting by a single observer (Ning Zhang) with the patient in the supine position. Radial images of the 4 quadrants and 1 centered on the anterior chamber were acquired. The central anterior chamber depth of each eye and the number of quadrants with irido-trabecular apposition under the two lighting conditions were recorded. If irido-trabecular apposition was present, that quadrant of the angle was evaluated as closed. Pupillary block was diagnosed if there was characteristic iris convexity. Plateau iris was diagnosed if there was the characteristic configuration of large anteriorly positioned ciliary processes obliterating the ciliary sulcus on UBM images. The configuration and occludability of the angles were recorded.

These two examiners were masked to the findings of each other.

Sample size and statistical analysis

The minimal sample size was calculated as 70 for a planned sensitivity of 90%, specificity of 90%, and permissible error of 0.1, with $\alpha=0.05$. Data were managed using EpiData 3.1 (EpiData Association, Odense, Denmark) and analyzed using SPSS 19.0. The agreement between gonioscopy and UBM was analyzed using Kappa analysis and the effects of different factors, including angle configuration, on the odds of agreement were analyzed using Chi-square test and single-factor analysis. $P<0.05$ was considered statistically significant.

RESULTS

Altogether 46 patients (30 female, 16 male, 85 eyes) were included in this study. The average age was 64.6 ± 9.8 years old. Angle closure was found in 70 eyes with gonioscopy and in 67 eyes with UBM in dark condition. 68 in the 70 angle closure eyes detected by gonioscopy were examined with UBM, and 58 of them (85.3%) were found

with angle closure. While in the light condition, 21 eyes were demonstrated with angle closure with gonioscopy and 39 eyes with UBM. Since gonioscopy is considered as the gold standard in practice, UBM had a sensitivity of 85.3% and specificity of 42.9% in dark condition, and a sensitivity of 71.4% and specificity of 62.5% in light condition. The prevalence of angle closure in different quadrants is shown in Table 1. With the UBM method, the anterior chamber depth was measured as 2.07 ± 0.29 mm on average. Among all the 85 eyes examined, 100% had pupillary block and 40 (47.1%) had plateau iris configuration.

Kappa analysis showed the kappa value between these two methods was 0.266 in dark condition ($P=0.016$) and 0.263 in light condition ($P=0.007$). The observed agreement between gonioscopy and UBM is the lowest in the temporal quadrant in dark condition (0.293), but rather high in light condition (0.894), while Kappa analysis showed no statistical significance (Tables 2, 3). As for other quadrants, poor agreement ($\text{kappa} < 0.4$) was shown between gonioscopy and UBM (Tables 2, 3).

The agreement between gonioscopy and UBM was not significantly affected by age, or sex (all $P > 0.05$). In eyes with smaller anterior chamber depth, the agreement in dark condition was better ($P=0.005$, Table 4). Eyes with plateau iris configuration tended to produce different results using different methods in dark ($P=0.075$) (Tables 4,5).

Table 1. Number of eyes with angle closure in different lighting conditions

Diagnostic methods	Quadrants			
	Superior	Nasal	Inferior	Temporal
G+Dark	67	67	67	68
G+Light	8	16	9	5
U+Dark	60	25	46	12
U+Light	32	12	27	4

G+Dark: gonioscopic examination in dim illumination; G+Light: gonioscopic examination in light condition; U+Dark: ultrasound biomicroscopy (UBM) in dark condition; U+Light: UBM in light condition.

Table 2. Kappa analysis for gonioscopy and UBM methods in detection of angle closure in dark condition

Quadrants	Observed agreement	Expected agreement	Kappa	P value
Superior	0.756	0.628	0.343	0.002
Nasal	0.476	0.379	0.156	0.017
Inferior	0.659	0.529	0.276	0.004
Temporal	0.293	0.284	0.012	0.788

Table 3. Kappa analysis for gonioscopy and UBM methods in detection of angle closure in light condition

Quadrants	Observed agreement	Expected agreement	Kappa	P value
Superior	0.671	0.600	0.176	0.022
Nasal	0.788	0.724	0.233	0.029
Inferior	0.718	0.644	0.207	0.017
Temporal	0.894	0.900	-0.055	0.609

Table 4. Analysis of factors related to agreement in dark condition

Factors	Agreement (64 eyes)*	Disagreement (18 eyes)*	t/χ^2	P value
Sex (male : female)	24 : 40	4 : 14	1.458	0.227
Plateau iris configuration (%)	42.86	66.67	3.179	0.075
Age ($\bar{x} \pm s$, years)	64.75 ± 9.563	64.24 ± 10.010	0.196	0.845
Anterior chamber depth ($\bar{x} \pm s$, mm)	2.022 ± 0.277	2.236 ± 0.281	2.899	0.005

*Due to the poor compliance in dark condition, 3 patients (3 eyes) were excluded from the analysis.

Table 5. Analysis of related factors about agreement in light condition

Factors	Agreement (55 eyes)	Disagreement (30 eyes)	t/χ^2	P value
Sex (male: female)	18:37	10:20	0.003	0.955
Plateau iris configuration (%)	50.91	41.38	0.691	0.406
Age ($\bar{x} \pm s$, years)	64.17 ± 10.631	63.93 ± 8.485	0.104	0.918
Anterior chamber depth ($\bar{x} \pm s$, mm)	2.054 ± 0.278	2.090 ± 0.301	0.561	0.576

DISCUSSION

Because the optic nerve damage is irreversible and prophylactic therapy of PACG is available, early diagnosis and treatment is very important in preventing blindness resulting from PACG. This study was focused on comparing two routine clinical methods, gonioscopy and UBM, in early detection of angle closure.

The present study shows that the sensitivity and specificity of UBM is not good enough to substitute gonioscopy as the standard procedure in detection of angle closure in

patients with shallow anterior chamber. The agreement between these two methods was marginal in both light and dark conditions. High agreement (89%) between these two examinations had been reported previously in patients with gonioscopy-defined appositional angle closure examined in complete darkness.¹² It is worth noticing that, if we take the data with the similarly defined condition for analysis in the present study, which means only eyes with angle closure found by gonioscopy in dim illumination were included, the agreement would be increased to 85.3% (58/68). However, in comparison of two examinations, it is necessary to take into account all the different possible results. It was reported that only limited agreement was found between UBM and gonioscopy among normal Chinese subjects in a population-based assessment,¹³ the result of which is similar with the present study.

Because of the low consistence between the results of gonioscopy and UBM, we made great effort to identify any factors that may interfere with the examination results. The agreement of temporal quadrant in dark condition was the lowest in this study. While in dark condition, eyes with deeper anterior chamber ($P=0.005$) or plateau iris configuration ($P=0.075$) tended to produce different results.

There are several possible explanations for the discrepancy between UBM and gonioscopic findings. First, gonioscopy is not perfect in detecting angle closure.⁹ Applying a gonioscope to the ocular surface may artificially widen or narrow the angle, which may result in misclassification of angles. For instance, when examining the temporal quadrant, the examiner has to observe the lens at the nasal side, which is not convenient to operate. It is also possible that plateau iris configuration may make it difficult to observe the angle. Gonioscopy requires a subjective assessment, where bias exists among different observers. Second, although UBM is a better choice to demonstrate the configuration of angle in dark,¹⁴ the eyecup may exert a compressive force on the sclera and artificially narrow the angle. The regular method now only detects 1 section in each quadrant, which may result in the missing of some information of the whole range of the angle. Furthermore, UBM is performed in the supine position, whereas gonioscopy is performed with the patient sitting. The gravity may change the configuration of the angle, especially the superior and the inferior parts. It is therefore not surprising that some disagreement exists between these two methods. To obtain a more accurate evaluation of the anterior chamber angle, it may be important to combine findings of these two methods together in clinical settings. Both gonioscopy and UBM are

indispensable methods for detecting angle closure in early diagnosis of PACG.

REFERENCES

1. Quigley HA. Number of people with glaucoma worldwide. *Br J Ophthalmol* 1996; 80:389-93.
2. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol* 2006; 90:262-7.
3. Wang N, Wu H, Fan Z. Primary angle closure glaucoma in Chinese and Western populations. *Chin Med J (Engl)* 2002; 115:1706-15.
4. Yip JL, Foster PJ, Gilbert CE, et al. Incidence of occludable angles in a high-risk Mongolian population. *Br J Ophthalmol* 2008; 92:30-3.
5. Aung T, Nolan WP, Machin D, et al. Anterior chamber depth and the risk of primary angle closure in 2 East Asian populations. *Arch Ophthalmol* 2005; 123:527-32.
6. Nolan WP, Aung T, Machin D, et al. Detection of narrow angles and established angle closure in Chinese residents of Singapore: potential screening tests. *Am J Ophthalmol* 2006; 141:896-901.
7. Johnson GJ, Foster PJ. Can we prevent angle-closure glaucoma? *Eye (Lond)* 2005; 19:1119-24.
8. Liang YB, Li SZ, Fan SJ, et al. The questionnaire study of screening and diagnosis for primary angle closure glaucoma in China. *Ophthalmol Chin* 2009; 18:28-32.
9. Friedman DS, He M. Anterior chamber angle assessment techniques. *Surv Ophthalmol* 2008; 53:250-73.
10. He M, Friedman DS, Ge J, et al. Laser peripheral iridotomy in eyes with narrow drainage angles: ultrasound biomicroscopy outcomes. *The Liwan Eye Study. Ophthalmology* 2007; 114:1513-9.
11. He M, Huang W, Zheng Y, et al. Anterior chamber depth in elderly Chinese: the Liwan eye study. *Ophthalmology* 2008; 115:1286-90.
12. Barkana Y, Dorairaj SK, Gerber Y, et al. Agreement between gonioscopy and ultrasound biomicroscopy in detecting iridotrabecular apposition. *Arch Ophthalmol* 2007; 125:1331-5.
13. Friedman DS, Gazzard G, Min CB, et al. Age and sex variation in angle findings among normal Chinese subjects: a comparison of UBM, Scheimpflug, and gonioscopic assessment of the anterior chamber angle. *J Glaucoma* 2008; 17:5-10.
14. Zou Y, Zhang N, Liu X. Iridotrabecular apposition under different illumination. *Chin J Optom Ophthalmol* 2008; 10:349-51.