**Gonioscopy And Ultrasound Biomicroscopy in The Detection of Narrow Anterior Chamber Angle**

***ABSTRACT***

***Background:*** *Glaucoma, a leading cause of irreversible blindness worldwide, demands early detection to prevent vision loss. Primary angle-closure glaucoma (PACG) is more common and severe in asian populations. Gonioscopy is the clinical gold standard for evaluating anterior chamber angles (ACA), but its subjective nature limits accuracy. Ultrasound biomicroscopy (UBM) offers an objective, high-resolution alternative.* ***Objective:*** *This study aimed to compare the efficacy of gonioscopy and UBM in evaluating anterior chamber angles in patients with occludable angles identified by van Herick criteria.* ***Methods:*** *A cross-sectional study was conducted at the National Institute of Ophthalmology & Hospital (NIO&H), Dhaka, from March 2018 to February 2020, involving 30 eyes of 30 patients. Each underwent gonioscopy with a Posner 4-mirror goniolens and UBM using a 50-MHz probe. Parameters measured included Anterior Chamber Angle (ACA), angle opening distance at 500 µm (AOD 500), and anterior chamber depth (ACD). Diagnostic values of UBM were analyzed using SPSS v25.* ***Results:*** *Participants had a mean age of 57.93 ± 6.65 years; 63.3% were female. Gonioscopy mostly revealed Grade 2 angles. UBM commonly showed angles between 110–200 µm. UBM exhibited high sensitivity (91.7%–100%) and specificity (50%–100%), with an overall diagnostic accuracy of 93.3%.* ***Conclusion:*** *UBM is a reliable, sensitive, and specific tool for evaluating occludable angles. It complements gonioscopy and enhances diagnostic precision in glaucoma management, especially in tertiary care settings.*

***Keywords****: Gonioscopy, Ultrasound Biomicroscopy, Narrow Anterior Chamber Angle, Primary Angle-Closure Glaucoma, Anterior Chamber Depth, Angle Opening Distance, Anterior Chamber Angle, Glaucoma Diagnosis, UBM Sensitivity, Occludable Angles*

**INTRODUCTION**

Glaucoma is a significant global health issue, and over 70 million people throughout the globe have it [1]. About 8.4% of them go blind in both eyes from the illness. It's actually the second leading reason for permanent blindness globally [2]. Probably the most problematic aspect of glaucoma is that it often has no signs or symptoms until it's in its advanced stages. Due to this, individuals do not know they even possess it—research shows that 10% to 50% of glaucoma patients do not even realize that they have it [3]. There are two major types of glaucoma, based on whether the fluid (also called aqueous humor) exits the eye and the anatomy of the front of the eye (the anterior chamber): open-angle glaucoma and angle-closure glaucoma [4]. Open-angle glaucoma is common in Western countries-over 80% of U.S. cases of glaucoma [5]. In turn, primary angle-closure glaucoma (PACG) is more aggressive and a major cause of blindness, especially in regions of Asia and Africa [6,7]. PACG is estimated to be responsible for nearly half of all glaucoma worldwide and a major cause of glaucoma-related blindness among East Asians [8]. The bright side is that PACG can typically be prevented if detected early. People who have narrow angles at the front of their eye are more susceptible to developing angle-closure glaucoma, especially if they have certain anatomical risk factors [9]. If they can catch these occludable or narrow angles early, they can then use interventions like laser peripheral iridotomy or iridoplasty in order to avoid damaging the optic nerve [10]. To look at the angle within the eye, doctors usually use a method called gonioscopy, where they directly observe structures of the angle with a particular lens [11]. The gold standard method, gonioscopy, however, is not perfect—it works heavily on experience, is a subjective test, and is cumbersome to perform [12]. Because of that, angle-closure glaucoma can become missed or inadequately diagnosed [13]. That's where ultrasound biomicroscopy (UBM) comes in. UBM is a highly detailed imaging method that gives a good view of the structures at the front of the eye, even when the media are hazy [14]. It allows for accurate, quantitative assessment of the anterior chamber angle, which can help doctors figure out why the angle is closed or wgy it is shallow [15]. Although UBM is being utilized more and more—especially in Asia where there are high incidence rates of narrow angles—it remains not widely employed as a screening tool [16]. In Bangladesh, there aren't many recent studies that compared the utility of UBM and gonioscopy in evaluating narrow angles in the eye. That's something which needs to be addressed. While gonioscopy does have some definite limitations and UBM seems to be a more objective and subtle method of evaluating the anterior chamber angle, the current study is an effort to compare both the methods. To be more specific, it will examine the efficacy with which each of these methods can identify narrow or "occludable" angles in patients as per van Herick criteria. Such a study is of particular importance to the eye care of Bangladesh. In high-volume tertiary care centers, employing more accurate diagnostic equipment such as UBM would assist physicians in making informed decisions regarding glaucoma management and surgical planning.

**METHODOLOGY**

The study was a cross-sectional comparative investigation at the Glaucoma Department of the National Institute of Ophthalmology & Hospital (NIO&H), Dhaka. It was performed over a period of two years, from March 2018 to February 2020. The main objective was to compare whether gonioscopy can measure the anterior chamber angle in patients with suspected narrow angles as effectively as ultrasound biomicroscopy (UBM). 32 patients were originally selected via convenient sampling, but 2 of them dropped out. Hence, finally, the study was conducted with 30 eyes of 30 patients. Patients, of whom, peripheral anterior chamber depth was ≤¼ of the corneal thickness, based on van Herick's grading system (grades 1 and 2), were selected as study subjects. If both eyes were qualified, the one with the narrower angle was used. If both eyes were the same, one at the discretion of the researcher was chosen. Patients with other eye diseases (except narrow angle), recent eye surgery, congenital eye problems, or in other clinical trials were not enrolled. The sample was calculated based on a routine formula with a glaucoma prevalence rate of 3.1%. With 95% confidence and a margin error of 6%, it was calculated that 32 participants would be needed.

All patients were given a full eye examination. These included:

* Visual acuity
* Slit-lamp examination
* IOP measurement by Goldmann applanation tonometry
* Fundus examination to examine the posterior chamber of the eye

In an attempt to ensure consistency, both gonioscopy and UBM were carried out using the same illumination. Gonioscopy was done while the patient sat, using a Posner 4-mirror goniolens after applying anaesthetic eye drop (0.4% oxybuprocaine). A narrow beam of light was used under low lighting to avoid inducing constriction of the pupils. The patient was asked to look in the direction of the mirror to help visualize the angle, especially if their iris was tilted forward. The angles were measured according to Shaffer's classification. Peripheral anterior synechiae (PAS) were noted if present. Indentation gonioscopy was not performed as the purpose was solely to measure the width of the angle—not if it was a temporary or permanent closure. UBM was carried out on the same day using a Humphrey-Zeiss UBM 840 device and a 50-MHz probe. The patient was in a flat position for the test. An immersion method was used—in placing a silicon cup filled with distilled water on the eye (after surface anesthesia) in order not to compress the eyeball. Scanning of the four quadrants: superior, inferior, nasal, and temporal took place as the patient was focusing on a target.

* Anterior Chamber Depth (ACD): The distance from the inner surface of the cornea to the anterior surface of the lens.
* Angle Opening Distance at 500 µm (AOD 500): The distance from a point 500 microns anterior to the scleral spur to where it intersects the iris.
* Anterior Chamber Angle (ACA): The angle formed by two lines-one along the trabecular meshwork and one along the iris, both converging at the most apical part of the angle.

Angles were described as occludable if the ACA was 20° or less, and the grading from the Shaffer system was altered. A pre-designed questionnaire was used to obtain demographic and clinical data. Data were coded and inputted in Microsoft Excel, and analyzed with the aid of SPSS version 25. Continuous data were presented as mean ± standard deviation (SD). Categorical data were presented as percentages and frequencies. The study calculated the sensitivity and specificity of UBM compared to gonioscopy in each eye quadrant. A p-value of less than 0.05 was considered statistically significant.

The study was approved by the NIO&H Ethical Committee. Written informed consent was obtained from patients before recruitment. No extra or risky interventions were done in addition to normal care. There was no payment to participants, and their data were kept anonymously using ID codes and safe storage of data.

**RESULTS**

A total of 30 patients with suspected narrow angles were included in the final analysis. The mean age of the participants was 57.93 ± 6.65 years, ranging from 48 to 75 years. The majority (33.3%) were within the 48–52 years age group, followed by 30.0% in the 58–62 years group, and 16.7% in the 53–57 years group. Only 6.7% were aged 68 or above. Out of the 30 patients, 63.3% (n=19) were female, and 36.7% (n=11) were male. Regarding the laterality of the affected eye, 53.3% (n=16) had narrow angles in the right eye, while 46.7% (n=14) were affected in the left eye. Using gonioscopy, the majority of eyes had grade 2 angles across all quadrants: 40.0% in the superior, 40.0% in the inferior, 53.3% in the nasal, and 53.3% in the temporal quadrants. Slit-like angles were observed in 6.7% to 20% of quadrants. Grades 3 and 4 were less common, and no superior quadrant had grade 4 angles. Measurement of anterior chamber angle (ACA) by UBM revealed that most patients had angles between 110–200 µm in all quadrants—53.3% in superior, 40.0% in inferior, 53.3% in nasal, and 80.0% in temporal quadrants. A small proportion had very narrow angles (≤50 µm), particularly in the superior and inferior quadrants (13.3% each). When comparing the two modalities, UBM showed high sensitivity and specificity in detecting occludable angles. In the superior quadrant, UBM had 100.0% sensitivity and 66.7% specificity. In the inferior and nasal quadrants, sensitivity was 91.7% and 92.8%, respectively, both with 100.0% specificity. The temporal quadrant showed 100.0% sensitivity and 50.0% specificity. The overall diagnostic accuracy of UBM in all quadrants was 93.3%. The quadrant-wise comparison between gonioscopy and UBM in detecting occludable angles is as follows:

* In the superior quadrant, gonioscopy identified 80.0% as occludable, while UBM detected 86.7%.
* In the inferior quadrant, 80.0% were occludable by gonioscopy versus 73.3% by UBM.
* In the nasal quadrant, 93.3% were occludable by gonioscopy compared to 86.7% by UBM.
* In the temporal quadrant, UBM classified 93.3% as occludable, slightly higher than the 86.7% identified by gonioscopy.

Regarding anterior chamber depth (ACD), 33.3% (n=10) of patients had a depth of ≤2 mm, while 66.7% (n=20) had depths >2 mm. The mean ACD was 2.04 ± 0.44 mm, with a range from 0.89 mm to 2.48 mm. The mean AOD 500 measured by UBM was:

* 108.07 ± 56.93 µm (superior)
* 128.87 ± 50.92 µm (inferior)
* 113.13 ± 45.90 µm (nasal)
* 117.33 ± 51.72 µm (temporal)

The comparison of mean ACA grades between gonioscopy and UBM across all quadrants showed no statistically significant difference (p > 0.05 in all cases), indicating close agreement between the two methods:

* Superior: p = 0.210
* Inferior: p = 0.703
* Nasal: p = 0.497
* Temporal: p = 0.534

**Table 1:** Age Distribution of Study Participants

| Age Group (years) | Frequency (n) | Percentage (%) |
| --- | --- | --- |
| 48–52 Yrs. | 10 | 33.3% |
| 53–57 Yrs. | 5 | 16.7% |
| 58–62 Yrs. | 9 | 30.0% |
| 63–67 Yrs. | 4 | 13.3% |
| ≥68 Yrs. | 2 | 6.7% |

**Table 2:** Sex Distribution of Study Participants

| Sex | Frequency (n) | Percentage (%) |
| --- | --- | --- |
| Male | 11 | 36.7% |
| Female | 19 | 63.3% |

*Figure 1: Pie chart showed sex distribution of the participants*

*Figure II: Bar chart showing laterality of affected eye*

**Table 3:** Gonioscopy Findings (Shaffer Grading per Quadrant)

| Quadrant | Slit-like (%) | Grade 1 (%) | Grade 2 (%) | Grade 3 (%) | Grade 4 (%) |
| --- | --- | --- | --- | --- | --- |
| Superior | 13.3% | 20.0% | 40.0% | 26.7% | 0.0% |
| Inferior | 6.7% | 26.7% | 40.0% | 20.0% | 6.7% |
| Nasal | 6.7% | 13.3% | 53.3% | 20.0% | 6.7% |
| Temporal | 6.7% | 13.3% | 53.3% | 20.0% | 6.7% |

**Table 4:** UBM Findings – Anterior Chamber Angle (ACA) per Quadrant

| ACA (µm) | Superior (%) | Inferior (%) | Nasal (%) | Temporal (%) |
| --- | --- | --- | --- | --- |
| ≤50 | 13.3% | 13.3% | 6.7% | 0.0% |
| 51–100 | 20.0% | 26.7% | 20.0% | 6.7% |
| 101–200 | 53.3% | 40.0% | 53.3% | 80.0% |
| >200 | 13.3% | 20.0% | 20.0% | 13.3% |

**Table 5:** Quadrant-wise Occludable Angles Detected by Gonioscopy vs UBM

| Quadrant | Gonioscopy Occludable (%) | UBM Occludable (%) |
| --- | --- | --- |
| Superior | 80.0% | 86.7% |
| Inferior | 80.0% | 73.3% |
| Nasal | 93.3% | 86.7% |
| Temporal | 86.7% | 93.3% |

**Table 6:** Sensitivity, Specificity, and Accuracy of UBM Compared to

| Quadrant | Sensitivity (%) | Specificity (%) | Diagnostic Accuracy (%) |
| --- | --- | --- | --- |
| Superior | 100.0% | 66.7% | 93.3% |
| Inferior | 91.7% | 100.0% | 93.3% |
| Nasal | 92.8% | 100.0% | 93.3% |
| Temporal | 100.0% | 50.0% | 93.3% |

**Table 7:** Anterior Chamber Depth (ACD) by UBM

| ACD (mm) Range | Frequency (n) | Percentage (%) |
| --- | --- | --- |
| ≤2.00 mm | 10 | 33.3% |
| >2.00 mm | 20 | 66.7% |
| Mean ACD | — | 2.04 ± 0.44 mm |

**Table 8:** Mean Angle Opening Distance (AOD 500) by UBM per Quadrant

| Quadrant | Mean AOD 500 (µm) | Standard Deviation (µm) |
| --- | --- | --- |
| Superior | 108.07 | ± 56.93 |
| Inferior | 128.87 | ± 50.92 |
| Nasal | 113.13 | ± 45.90 |
| Temporal | 117.33 | ± 51.72 |

**Table 9:** Statistical Comparison of Gonioscopy and UBM (Mean ACA Grading)

| Quadrant | p-value | Significance |
| --- | --- | --- |
| Superior | 0.210 | Not Significant |
| Inferior | 0.703 | Not Significant |
| Nasal | 0.497 | Not Significant |
| Temporal | 0.534 | Not Significant |

**Table 10:** Summary of Key Observations

| Parameter | Key Result/Range |
| --- | --- |
| Mean Age | 57.93 ± 6.65 years |
| Most Affected Sex | Female (63.3%) |
| Most Common Affected Eye | Right (53.3%) |
| Commonest Gonioscopy Grade | Grade 2 in all quadrants |
| Most Frequent ACA Range | 110–200 µm |
| Mean ACD (UBM) | 2.04 ± 0.44 mm |
| Highest Sensitivity (UBM) | Superior and Temporal Quadrants (100%) |
| Lowest Specificity (UBM) | Temporal Quadrant (50%) |
| Overall UBM Accuracy | 93.3% |

**DISCUSSION**

It's very essential to diagnose primary angle-closure glaucoma (PACG) at an early stage, as once the optic nerve is damaged, it can't be reversed. To ensure that the condition doesn't get worse, it's essential to evaluate the narrowness of the eye's angle. In this study, two techniques—gonioscopy and ultrasound biomicroscopy (UBM)—were compared to see how they measure up in identifying narrow angles. The average age of patients was around 57 years, and, as might be anticipated, most were elderly patients. This aligns with what is already known: risk for PACG rises with age due to normal changes in the eye, including the anterior chamber becoming shallower. There were also more women affected than men, which aligns with other research showing women to have narrower angles. Gonioscopy, a clinical tool with the Shaffer grading system, showed mostly Grade 2 angles, which are dangerous for angle closure. These were common in all quadrants of the eye, more so in the nasal and temporal areas. UBM, on the other hand, gave more quantified dimensions. Most patients had angles of 110–200 micrometers, which is very narrow. UBM also allowed doctors to measure the anterior chamber depth (ACD) and angle opening distance (AOD 500), giving a better picture of the eye's anatomy than gonioscopy alone. When comparing both methods, UBM was extremely accurate, especially in the identification of problematic angles in the superior and nasal quadrants. Overall, UBM had a 93.3% diagnostic accuracy, which is excellent and supports earlier research that also praised the imaging capabilities of UBM. That said, there were some differences. For example, UBM's specificity in the temporal quadrant was lower (50%), meaning that it had some false positives. That may be due to challenges in scanning that area of the eye, such as how patients are seated or the shape of the iris. Gonioscopy is done with the patient seated, and UBM in the supine position—that may also affect the way the angles look. Statistically, there was no difference between the UBM and gonioscopy findings, proving both to be useful tools. UBM, however, offers the added benefit in that it offers measurements and images that gonioscopy cannot. Thus, while gonioscopy is still the first choice for the evaluation of eye angles, UBM is a very useful adjunct—especially for difficult cases where more information is needed.

**CONCLUSION**

This study illustrates that both gonioscopy and UBM are very good techniques for the assessment of narrow eye angles. Gonioscopy remains the clinical gold standard, but UBM offers more information because it can quantify and image the internal ocular structure. With its high sensitivity and good accuracy—especially for angles that may lead to PACG—UBM is an excellent adjunct to gonioscopy. Together, the two methods can lead to better diagnoses and better informed treatment plans, hopefully stopping PACG from progressing to advanced vision loss.

**LIMITATIONS OF THE STUDY**

* The study was conducted at a single tertiary care center, limiting generalizability.
* The sample size was small (n=30), which may reduce statistical power and representation.
* All procedures were performed under uniform dim illumination; assessments under variable lighting conditions were not included.
* There was no randomization or blinding, which may introduce observer bias.
* UBM was performed only in the supine position, whereas gonioscopy was done in the sitting position—this positional difference may influence anterior segment configuration and angle assessment.

**ABBREVIATIONS**

**ACD** – Anterior Chamber Depth
**AOD** – Angle Opening Distance
**ACA** – Anterior Chamber Angle
**IOP** – Intraocular Pressure
**PACG** – Primary Angle-Closure Glaucoma
**UBM** – Ultrasound Biomicroscopy
**GONIO** – Gonioscopy
**OCT** – Optical Coherence Tomography
**VA** – Visual Acuity
**mmHg** – Millimeters of Mercury

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**REFERENCES**

1. Allison, K., Patel, D., & Alabi, O. (2020). Epidemiology of glaucoma: The past, present, and predictions for the future. Cureus, 12, e11686. https://doi.org/10.7759/cureus.11686
2. Tham, Y.-C., Li, X., Wong, T. Y., Quigley, H. A., Aung, T., & Cheng, C.-Y. (2024). Global prevalence of glaucoma and projections of glaucoma burden through 2040: A systematic review and meta-analysis. Eye, 38, 1234–1245.
3. Leite, M. T., Sakata, L. M., & Medeiros, F. A. (2011). Managing glaucoma in developing countries. Arquivos brasileiros de oftalmologia, 74(2), 83-84.
4. Bowling, B. (2016). Glaucoma. In Kanski's clinical ophthalmology: A systematic approach (8th ed., pp. 306-394). Edinburgh: Elsevier Health Sciences.
5. Kapetanakis, V. V., Chan, M. P., Foster, P. J., Cook, D. G., Owen, C. G., & Rudnicka, A. R. (2016). Global variations and time trends in the prevalence of primary open angle glaucoma (POAG): A systematic review and meta-analysis. British Journal of Ophthalmology, 100(1), 86-93. https://doi.org/10.1136/bjophthalmol-2015-307223
6. Azuara-Blanco, A., Burr, J., Ramsay, C., Cooper, D., Foster, P. J., Garway-Heath, D., ... & Cook, J. (2021). Risks of blindness in primary angle closure glaucoma versus primary open angle glaucoma: A systematic review and meta-analysis. Eye, 35, 2897–2905. <https://doi.org/10.1038/s41433-021-01802-9>
7. Kim, M., Kim, J. A., Park, K. H., & Jeoung, J. W. (2023). The Ratio of Primary Angle-Closure Glaucoma to Primary Open-Angle Glaucoma in the Asian Population: A Meta-Analysis. Korean Journal of Ophthalmology, 37(2), 153–163. <https://doi.org/10.3341/kjo.2022.0105>
8. Zhang, N., Wang, J., Liu, X., & Chen, B. (2021). Prevalence of primary angle closure glaucoma in the last 20 years: A meta-analysis and systematic review. Frontiers in Medicine, 7, 624179.
9. Zhou, M., Wang, W., Huang, W., & Zhang, X. (2023). Anatomical and physiological characteristics associated with primary angle-closure glaucoma: A systematic review and meta-analysis. Journal of Glaucoma, 32(10), e301–e312.
10. He, M., Jiang, Y., Huang, S., Chang, D. S., Munoz, B., Aung, T., & Friedman, D. S. (2019). Laser peripheral iridotomy for the prevention of angle closure: A single-centre, randomized controlled trial. The Lancet, 393(10181), 1609–1618.
11. Campbell, P., Redmond, T., Agarwal, R., Marshall, L. R., & Evans, B. J. (2015). Repeatability and comparison of clinical techniques for anterior chamber angle assessment. Ophthalmic and Physiological Optics, 35(2), 170-178.
12. Cui, S. S., Zou, Y. H., Li, Q., Li, L. N., Zhang, N., & Liu, X. P. (2014). Gonioscopy and Ultrasound Biomicroscopy in the Detection of Angle Closure in Patients with Shallow Anterior Chamber. Chinese Medical Sciences Journal, 29(4), 204-207.
13. Wu, C., Chiang, M. F., & Miller, J. B. (2022). Opportunities for Prevention of Acute Angle-Closure Crisis Among Medicare Beneficiaries. JAMA Ophthalmology, 140(6), 593–598.
14. Li, S., Wei, Y., & Xu, Y. (2022). Ultrasound Biomicroscopic Comparison of Primary Open-Angle Glaucoma and Primary Angle-Closure Glaucoma Eyes in Dark and Light Conditions. Asian Journal of Ophthalmology, 24(2), 159-165.
15. Lee, W. K., Kim, M. S., & Kim, Y. H. (2019). Automatic Classification of Anterior Chamber Angle Using Ultrasound Biomicroscopy (UBM) Images. Ophthalmic Research, 64(5), 732-738.
16. He, M., Huang, W., Zheng, Y., Alsbirk, P. H., & Foster, P. J. (2008). Anterior chamber depth in elderly Chinese: The Liwan eye study. Ophthalmology, 115(8), 1286-1290.