Research Article

GONIOSCOPY VERSUS ANTERIOR SEGMENT OCULAR COHERENCE TOMOGRAPHY FOR ANTERIOR CHAMBER ANGLE ASSESSMENT. A COMPARATIVE STUDY.

Ghulam Mujtaba Sohu[1], Zulkarnain Abbasi[1], Jalpa Bai[2], Noman Ahmed Shaikh[1], Asadullah Jatoi[1], Ashok Kumar Narsani[1]

[1]Institute of Ophthalmology, Liaquat University of Medical and Health Sciences Jamshoro, Pakistan, [2]Molecular Biology and Genetics Department, Liaquat University of Medical and Health Sciences, Jamshoro.

Correspondence:
Ashok Kumar Narsani
Professor of Ophthalmology
Institute of Ophthalmology, Liaquat University of Medical and Health Sciences Jamshoro, Pakistan
Email: ashok.narsani@lumhs.edu.pk

DOI: 10.38106/LMRJ.2024.6.3-02
Received: 24.06. 2024
Accepted: 09.09.2024
Published: 30.09.2024

ABSTRACT

This study was conducted to determine the anterior chamber angle to improve the diagnostic accuracy, treatment modalities and health outcomes in individuals with angle-closure glaucoma. This was a comparative cross-sectional study at the Institute of Ophthalmology Liaquat University of Medical and Health Sciences, Jamshoro, Sindh, Pakistan. Patients with various ocular conditions presented at Glaucoma clinic, aged 20 years old or above of either gender were included. After obtaining written informed consent, the gonioscopy and anterior segment optical coherence tomography (AS-OCT) imaging was done in all participants. A trained ophthalmology resident presented the Questionnaire in the local language, while a consultant ophthalmologist performed the complete general ocular evaluation, slit-lamp examination, gonioscopy and anterior segment optical coherence tomography. Out of 178 participants, 146 (82%) patients were male patients, and 32 (18%) were females. The majority of patients, 79 (44.4%), were aged between 41 to 50 years, while 51 (28.7%) were over 60 years old. AS-OCT has shown to enhance health outcomes, diagnostic accuracy, and treatment modalities compared to gonioscopy in patients with angle-closure glaucoma. The findings from anterior segment OCT were significant ($p < 0.001$) in comparison to gonioscopy.

In conclusion this study revealed that both gonioscopy and AS-OCT imaging identified the upper quadrant as having the highest prevalence of angle closure. However, the relative incidence of closed angles in the other quadrants varied depending on the modality utilized. Some of these variations may be explained by specifics in how each technique's ACA configuration is assessed and interpreted.

Key words: Anterior Chamber, Anterior segment OCT, Glaucoma.

INTRODUCTION

Glaucoma is a type of eye illnesses that induce harm to the optic nerve, which indeed is necessary for vision(1). Exceptionally high ocular pressure is usually the cause of this damage. Glaucoma is one of the most frequent causes of irreversible blindness in individuals over the age of 60(2). The trabecular meshwork provides greater resistance to fluid outflow in open-angle glaucoma. As a result, the intraocular pressure rises and damage the optic nerve(3). The anterior chamber angle (ACA) must be measured in order to identify individuals with angle closure and correctly classify glaucoma(4). The cornea, anterior chamber aspect, aqueous discharge route, conjunctiva, and ocular surface properties are all evaluated using anterior segment optical coherence tomography, which has emerged as one of the non-contact imaging paradigms' cornerstones(5). As a result, it has a wide range of therapeutic uses, all of which have been independently described in the literature5. The anterior chamber angle of an eye must be evaluated in order to appropriately diagnose individuals with closed angles(6). Although gonioscopy is the current gold standard for determining anterior chamber inclination, its disadvantages, such as its subjectivity, the requirement for training, and high variability among the clinicians, have prompted research in alternative assessment techniques(7). Based on gonioscopy, it is acknowledged that Most eyes' ACAs differ anatomically, with the superior quarter becoming the shortest, the inferior quarter has always been the widest, and the temporal and nasal regions being somewhere in the middle(8).

The upper quadrant of the angle is the narrowest, according to AS-OCT research defining the anatomic variance of the ACA(9). On AS-OCT, the temporal and nasal quadrants are often broader than the inferior quadrant. On multi-image AS-OCT, there is also a significant anatomic diversity of the ACA(10).

The AS-OCT, on the contrary side, provides a quick, noncontact means of assessing angles that may be both subjective and quantitative(11). Its technical specialists have been extensively detailed, and angle evaluation with AS-OCT has been found to somewhat correspond with gonioscopy(12).

The van Herick test, which determines which patients should have gonioscopy based on the ratio of the periphery anterior chamber width to the outer corneal thickness is frequently used to decide whether individuals should receive gonioscopy(13). The main issue with this method is that it lacks sufficient sensitivity and specificity to detect all individuals with angle closure(13). In one study, the gonioscopy was compared to the van Herick test, which were carried out by specialists, trainees, and medical students, The van Herick test has a sensitivity of just 58 to 79 percent for detecting angle closure(14).

Gonioscopy, a short examination that requires contact with the cornea and is frequently regarded as tiring in a busy clinical practice, is the existing reference standard for assessing the ACA configuration(15). Moreover, gonioscopic findings may be altered even during inspection by accidental tension on the gonioscopy lens and intensity of light. Previous study has demonstrated that even professional, trained examiners had only a small level of consensus when calculating angle width(16). Due to existing controversies in the literature regarding the utility of AS-OCT, together with recommendations for further studies to elucidate its efficacy (17), and the lack of sufficient local literature, this study was conducted, to compare the accuracy of both procedures, gonioscopy and AS-OCT in diagnosing angle closure in patients seeking ocular therapy at a general hospital. Additionally, the study aimed to assess any disparities in results between the two procedures across successive levels of the anterior chamber angle (ACA).

METHOD

A comparative cross-sectional study was conducted at Institute of Ophthalmology Liaquat University of Medical and Health Sciences, Jamshoro, Sindh, Pakistan. Study was conducted for 1-year from 5/4/2021to 4/4/2022. A non-probability convenient sampling technique was used. Ethical approval was obtained from the Ethical Review Committee of LUMHS Jamshoro. Sample size calculation was done by Epi-Info™ version 7.2. Using a 3.4% prevalence of blindness in Pakistan (9), applying a margin of error of 5% and 95% confidence interval [CI]), a sample size of 178 was estimated. All the patients with narrow angle, aged 20 years old or above and both genders were included. Patients with history of previous intraocular surgery or a traumatic eye injury, individuals with corneal abnormalities such as corneal endothelial degeneration, pterygium, or corneal scarring that may limit adequate imaging, as well as those using drugs that affect the pupil and patients who have already undergone laser radial iridotomy were excluded.

After obtaining written informed consent and explanation of the study aims and objectives, all the participants underwent gonioscopy and anterior segment optical coherence tomography imaging. A trained ophthalmology resident presented the Questionnaire in the local language, while consultant ophthalmologist performed the complete general ocular evaluation and slit-lamp examination.

The Gonioscopy was done in all selected patients to determine the grades and later on anterior segment OCT was done on same patient and the grade of the angle was determined. The examiner was an experienced ophthalmologist with substantial gonioscopy expertise in a research context. The light beam was shortened to I-mm beam to fit through a small slit, and the vertical beams were offset horizontally for both vertical positions i-e

superior and inferior orientations, while vertical beam for horizontal positions to assess the angles nasally and temporally. The Gonioscopy performed both static and dynamic at a high amplification (×16) with the eye in the regular position of gazing, correspondingly, using a Goldman 3-mirror lens. During the examination, precautions were made to avoid the falling of light on the pupil and unintentional indentation. Some angling of the Gonio-lens was done to provide a view across the contour of the iris. According to the anatomic features identified during gonioscopy, the Scheie grading technique was used to classify the ACA in each quadrant.

The Swept source (Topcon) OCT machine was used for AS-OCT. Three consecutive images of ACA in each eye were acquired under dim environment. The surgeon gently lowers the lower eyelid to photograph the lower angle, and gently raised the upper eyelid while imaging the upper angle to avoid the interfere the eyelids while imaging angle at 6 o'clock and at 12 o'clock. OCT image data was transferred to a personal computer and analyzed for the being assess the anterior chamber angle whether open or closed.

On a gonioscopy, the ACA was supposed to narrow angle or closed if without indentation the posterior part of trabecular meshwork was not detectable in the dominant position. On AS-OCT imaging, a quadrant was considered closed if angle wall was present anterior to the scleral spur and in contact with peripheral iris.

Statistical Methods

The data was collected and analyzed by using Statistical Package for Social Sciences (SPSS version 22.0, IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp) Frequency, proportions, and percentages were employed to describe categorical data, and the Pearson chi - square test was performed to examine the relationship. The mean and standard deviation for continuous variables were given, and any differences were determined using a t-test. The statistical significance value was determined using a p-value of 0.05.

RESULT

Out of 178 patients, the majority fell within the 41 to 50 age group, constituting 44.4%, followed by those over 60 years old, comprising 28.7% of the study population. Conversely, the 31 to 40 and 51to 60 years age groups represented 7.3% and 19.7% of the patients, respectively. In terms of gender, males accounted for a significant majority at 82%, while females were 18%. Regarding residential status, a slightly higher percentage of patients hailed from urban areas (56.7%) compared to rural areas (43.3%). Occupational diversity was evident, with technicians comprising the largest proportion at 24.7%, followed by retired individuals at 28.7%. Other occupations included housewives (18.0%), drivers (10.7%), mechanics (9.0%), and shopkeepers (9.0%) as shown in **Table 1.**

In the gonioscopy findings, Grade 3 accounted for 32.0% of individuals, while Grade 4 was not found. Conversely, AS-OCT revealed Grade 4 findings in a significant majority, constituting 68% of cases, with no instances of Grade 3 observed. Statistical analysis revealed a highly significant difference ($p < 0.001$) between the two modalities. This comparison underscores the superior sensitivity of AS-OCT in detecting Grade 4 angles compared to gonioscopy.

Table 2. The number of quadrants with closed ACA detected on gonioscopy and OCT images of the anterior segment of the four quadrants of 356 eyes is shown in **Table 3.**

Table. 1. Bassline characteristics of the patients (n=178)

Variables		Frequency	Percentage
Age groups	31-40 years	13	(7.3%)
	41-50 years	79	(44.4%)
	51-60 years	35	(19.7%)
	>60 years	51	(28.7%)
Gender	Male	146	(82%)
	Female	32	(18%)
Residential status	Rural	77	(43.3%)
	Urban	101	(56.7%)
Occupational	Driver	19	(10.7%)
	Housewives	32	(18.0%)
	Technician	44	(24.7%)
	Mechanics	16	(9.0%)
	Retired peoples	51	(28.7%)
	Shopkeepers	16	(9.0%)

Table 2. AS-OCT findings versus Gonioscopy findings n=178

Gonioscopy findings (Shaffer's grading)	*AS-OCT findings*		*P value*
	Grade 3	**Grade 4**	
Grade 3	57 (32.00%)	0 (0.00%)	**<0.001***
Grade 4	0 (0.00%)	121 (68.00%)	

Table.3 The number of quadrants with closed ACA detected on gonioscopy and OCT images of the anterior segment of the four quadrants of 356 eyes.

Quadrants	*No. Closed on AS-OCT (%, 95% Confidence Interval)*	*No. Closed on Gonioscopy (%, 95% Confidence Interval)*	*P Value**
Superior	149 (47, 43-52)	150 (30, 26-34)	0.05
Inferior	126 (44, 40-49)	95 (21, 17-25)	0.002
Nasal	56 (17, 14-21)	51 (15, 12-19)	0.12
Temporal	25 (13, 10-16)	60 (19, 15-23)	<0.001
Total	356 (31, 29-34)	356 (20, 18-22)	0.04

DISCUSSION

Glaucoma stands as a prevalent cause of blindness among individuals aged 60 and above. Detecting and averting angle closure early could halt the advancement to blindness in around 70% of instances (18,19). Investigators can get comprehensive cross-sectional pictures of the ACA using anterior segment OCT equipment without contact with the globe. These photos can be qualitatively analyzed therefore, the operation is quick and painless for the patient. It is also possible that there is less distortion of angle morphology as a result of the lack of globe modification. When gonioscopy is used as a reference standard, AS-OCT has a sensitivity of 98%. In low light situations, moreover, AS-OCT revealed visual contact between the iris and the anterior structures to the scleral spur in several eyes where gonioscopy showed open angles. Most eyes with angle closure identified by AS-OCT had a Spaeth gonioscopy grade of 0° to 20°. However, when evaluated by quadrant, a limited proportion of instances with gonioscopy angle widths of 20° are closed on AS-OCT pictures. In aligns to this study Kunimatsu et al (20)

examined the anterior chamber angle of 80 individuals with shallow anterior chambers in periphery, using ultrasonic bio microscopy (UBM) and discovered that the superiorly had the greatest percentage of closed angles (79%), followed by the inferiorly (64%), nasally (33%), and temporally (33%). Consistently Desmond T et al (17) concluded that AS-OCT exhibits promising sensitivity in detecting angle closure, potentially offering a solution to the prevalent issue of undiagnosed angle closure, particularly prevalent in developing Asian nations. Nonetheless, AS-OCT has not reached the point where it can supplant gonioscopy. Hence, clinicians must assess whether the diagnostic precision of AS-OCT aligns with their specific clinical requirements before incorporating it into practice. In the comparison of this study Esporcatte BL et al (18) also observed that the AS-OCT outperformed gonioscopy in detecting angle closure among patients with a shallow anterior chamber. In the present investigation, the AS OCT was employed to corroborate these results. The superior quadrant has the most closed ACAs, with the lower quadrant close behind. In eyes with just one or two closed ACA quadrants, the superior and inferior quadrants if these quadrants were not scanned, there was a probability of overlooking of angle closure in several eyes.

Generally, the concordance among AS OCT and gonioscopy in detecting a sealed ACA quadrant was excellent as in a prior study (9), the consistency was fair as compared to gonioscopy, AS OCT revealed more enclosed ACAs. When the two systems contrasted, the OCT preferred to see temporal aspects as open when they seemed sealed gonioscopically. The differences in outcomes between AS OCT and gonioscopy in various four directions might be due to technological difficulties in carrying out each operation. Viewing the temporal angles, for example, may be tough. According to Nolan et al (9), the distinction between the two methods may be accounted in part-gonioscopy may artificially open the ACA due to inadvertent indentation and excessive light. The difference in findings among gonioscopy and AS OCT might have been attributed, compared to 26% of quadrants defined as closed by both procedures. Angular closure has been considered to be an arbitrary connection between the iris and the angular wall proximally to the scleral spine, but this short iris angular interaction in AS OCT is considered angular closure. On gonioscopy, it is possible that the quadrant was not recorded as atresia because the gonioscopist judged ACA only by viewing the majority of the posterior glomerulus through the quadrant. In this study using Swept Source OCT, the manifestation of steep, supposed to be over-hill iris configurations was subjectively detected in 51% of cases. The ACA is considered closed by gonioscopy, but is considered open by Swept Source OCT. In such cases, it is possible that critical measurements of the iris interfered with the unfiltered view of angular structures using the gonioscopy lens, resulting in a closed ACA impression as observed with gonioscopy. There seems to be Another possibility is that the edge of the gonioscope was unexpectedly compressed when attempting to view the iris contour, causing unwanted mechanical deformation of the cornea and shaping the anterior chamber angle look artificially narrow(10,21). In such cases, either the gonioscopist detected an angle open regardless of a steep iris contour, or the ACA was artificially opened by light or accidental squeeze during gonioscopy.

However AS-OCT assessment of ACA in each quadrant is grounded solely on angular cross-sectioned images, and it is possible that there were anomalies in quadrants missing in that image. This study showed that many ACA images taken by AS OCT can be assessed, especially when performed by untrained personnel or assessed by independent viewers. There may be a large number of imageries in the clinical setting where ACA status cannot be concluded without practical knowledge and experience. A particular attention paid may cause systematic bias in gonioscopy data, which is considered as a limitation of the study.

CONCLUSION

This study revealed that both methods of anterior chamber angle assessment i-e gonioscopy and AS-OCT imaging identified the superior quadrant as having the excessive prevalence of closed angles. However, the relative incidence of closed angles in the other quadrants varied depending on the modality employed. These discrepancies

may stem from differences in how each technique assesses and interprets the anterior chamber angle (ACA) configuration. The clinical significance of findings of AS-OCT in managing patients with angle closure warrants further investigation through long-term prospective trials. As this study represents a novel endeavor at the local level, similar investigations should be conducted in every teaching hospital with ophthalmic services and access to anterior segment OCT. The accumulation of additional data from such studies would enhance the sensitivity and specificity of our findings, ultimately benefiting patients on a larger scale.

Acknowledgments

The authors would like to thank Haji Khan and Talib Hussain at Institute of Ophthalmology LUMHS, Jamshoro.

Conflict of Interest:

Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(LUMHS/REC/-62).**

REFERENCES

1. Ling HW. The importance of correcting energy imbalances and chakras energy deficiencies in the treatment of patients with glaucoma. Clin Res Ophthalmol. 2019;2(2):1–9.
2. Thakur S, Srivastava N, Patle D. Glaucoma: A review. Curr Trends Biotechnol Pharm. 2020;14(2):217–28.
3. Buffault J, Labbé A, Hamard P, Brignole-Baudouin F, Baudouin C. The trabecular meshwork: Structure, function and clinical implications. A review of the literature. J Fr Ophtalmol. 2020;
4. Fu H, Li F, Sun X, Cao X, Liao J, Orlando JI, et al. AGE challenge: Angle Closure Glaucoma Evaluation in Anterior Segment Optical Coherence Tomography. Med Image Anal. 2020;66.
5. Wang SB, Cornish EE, Grigg JR, McCluskey PJ. Anterior segment optical coherence tomography and its clinical applications. Clin Exp Optom. 2019;102(3):195–207.
6. Porporato N, Baskaran M, Husain R, Aung T. Recent advances in anterior chamber angle imaging. Eye. 2020;34(1):51–9.
7. Cutolo CA, Bonzano C, Scotto R, Iester M, Bagnis A, Pizzorno C, et al. Moving beyond the slit-lamp gonioscopy: Challenges and future opportunities. Diagnostics. 2021;11(12).
8. Xu BY, Pardeshi AA, Burkemper B, Richter GM, Lin SC, McKean-Cowdin R, et al. Differences in anterior chamber angle assessments between gonioscopy, eyecam, and anterior segment OCT: The Chinese American eye study. Transl Vis Sci Technol. 2019;8(2).
9. Xu BY, Friedman DS, Foster PJ, Jiang Y, Pardeshi AA, Jiang Y, et al. Anatomic Changes and Predictors of Angle Widening after Laser Peripheral Iridotomy: The Zhongshan Angle Closure Prevention Trial. Ophthalmology. 2021;128(8):1161–8.
10. Ang M, Baskaran M, Werkmeister RM, Chua J, Schmidl D, Aranha dos Santos V, et al. Anterior segment optical coherence tomography. Prog Retin Eye Res. 2018;66:132–56.
11. Benitez-del-Castillo J, Nowrouzi A, Rodriguez-Calzadilla M, Mota-Chozas I, Pinazo-Duran MD. Detection of occludable angle with anterior segment optical coherence tomography and Pentacam as non-contact screening methods. Int Ophthalmol. 2022;
12. Karvonen E, Stoor K, Luodonpää M, Hägg P, Kuoppala J, Lintonen T, et al. Prevalence of glaucoma in the Northern Finland Birth Cohort Eye Study. Acta Ophthalmol. 2019;97(2):200–7.
13. Johnson T V., Ramulu PY, Quigley HA, Singman EL. Low Sensitivity of the Van Herick Method for Detecting

Gonioscopic Angle Closure Independent of Observer Expertise. Am J Ophthalmol. 2018;195:63–71.

14. Radhakrishnan S. Diagnosing Angle Closure: Gonioscopy vs. OCT. Rev Ophthalmol. 2019;(April):60–4.

15. Rigi M, Bell NP, Lee DA, Baker LA, Chuang AZ, Nguyen D, et al. Agreement between Gonioscopic Examination and Swept Source Fourier Domain Anterior Segment Optical Coherence Tomography Imaging. J Ophthalmol. 2016;2016.

16. Ma P, Wu Y, Oatts J, Patlidanon J, Yu Y, Ying GS, et al. Evaluation of the Diagnostic Performance of Swept-Source Anterior Segment Optical Coherence Tomography in Primary Angle Closure Disease. Am J Ophthalmol. 2022;233:68–77.

17. Desmond T, Tran V, Maharaj M, Carnt N, White A. Diagnostic accuracy of AS-OCT vs gonioscopy for detecting angle closure: a systematic review and meta-analysis. Graefe's Archive for Clinical and Experimental Ophthalmology. 2021 Jul 5:1-23.

18. Esporcatte BL, Vessani RM, Melo Jr LA, Yanagimori NS, Bufarah GH, Allemann N, Tavares IM. Diagnostic performance of optical coherence tomography and nonspecialist gonioscopy to detect angle closure. Journal of Current Glaucoma Practice. 2022 Jan;16(1):53.

19. Smith SD, Singh K, Lin SC, et al. Evaluation of the anterior chamber angle in glaucoma: a report by the American academy of ophthalmology. *Ophthalmology.* 2013;120(10):1985–1997.

20. Chan PP, Pang JC, Tham CC. Acute primary angle closure–treatment strategies, evidences and economical considerations. Eye. 2019;33(1):110–9

21. Sun X, Dai Y, Chen Y, Yu DY, Cringle SJ, Chen J, et al. Primary angle closure glaucoma: What we know and what we don't know. Prog Retin Eye Res. 2017;57:26–45