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Original Article *Glaucoma*

Observational and non-interventional study to evaluate angle parameters of patients with or without the diagnosis of glaucoma

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ABSTRACT

Purpose: The aim of the study was to assess the different parameters of anterior chamber angle (AA) with anterior segment optical coherence tomography (OCT) in patients with or without the diagnosis of glaucoma.

Methods: A cross-sectional and observation study of angle parameters for clinically diagnosed, undiagnosed, and suspected patients of angle closure was done. Patients with glaucoma suspect not having angle closure were also included in the study. AAs (nasal and temporal), AC depth (ACD), AC area (ACA), and central corneal thickness (CCT) were assessed using Cirrus high-definition optical coherence tomography.

Results: Total 349 eyes of 178 patients with mean age of 41.31 ± 13.61 years were analyzed. One hundred and six of them were female (59.55%) and 72 were male (40.45%). The mean values of CCT were 540.85 ± 39.99 µm, 536.44 ± 41.25 µm; ACD were 2.37 ± 0.5 mm, 2.45 ± 0.4 mm, ACA were 17.04 ± 5.20 mm², 17.48 ± 4.47 mm², and AC width were 11.10 ± 0.45 mm, 14.13 ± 0.39 mm for the right and left eyes, respectively. The mean AA for the right and left eyes were nasal 22.23° ± 14.57°, 24.14° ± 14.10°; temporal 25.18° ± 14.13°, 25.88° ± 13.55°, respectively.

Conclusion: The nasal AA was found to be significantly narrower than the temporal angle in both right and left eyes; and the angle asymmetry increases with increasing age.

Keywords: Angle parameters, Anterior segment optical coherence tomography, Cirrus high-definition optical coherence tomography 500, Glaucoma

INTRODUCTION

The global prevalence of glaucoma, the second leading cause of blindness worldwide, for the population aged 40–80 years is 3.54% of which the prevalence of primary open angle glaucoma (POAG) is highest in Africa and that of primary angle closure glaucoma (PACG) is highest in Asia.[1] Angle closure disease according to definition of International Society for geographical and epidemiological ophthalmology is classified as primary angle closure suspect (PACS), primary angle closure (PAC), and PACG.[2] During the COVID-19 pandemic, gonioscopy was recommended to be performed at the discretion of surgeon with appropriate precautions.[3] Hence, the non-contact procedure of anterior segment optical coherence tomography (AS-OCT) was performed alternately. The present study will primarily discuss the anatomic parameters in patients with or without the diagnosis of glaucoma obtained in AS-OCT.

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MATERIAL AND METHODS

We conducted an observational cross-sectional study in angle closure suspects, diagnosed and undiagnosed cases of PACG and glaucoma suspects (GS). A person with one or more risk factors that raised the possibility of developing glaucoma later is identified as GS. The risk factors include elevation of intraocular pressure; optic nerve head, retinal nerve fiber layer and visual field abnormalities suggestive of glaucoma; abnormal angles, and family history of glaucoma.[4] Three hundred and forty-nine eyes (total of 178 patients) with at least one eye with PACS, PAC, PACG, and GS were enrolled in the study. The study was conducted at the glaucoma clinic of a tertiary eye care center. The study period was from June 2020 to December 2022. Comprehensive ophthalmic examinations including visual acuity, refraction, slit lamp examination, rebound tonometry, and posterior segment evaluation were done for all patients. The study was conducted in accordance with Declaration of Helsinki. Informed written consent was provided by all patients. Hospital Ethics Committee approval was obtained.

Study device - AS-OCT

AS images can be taken with OCT which is a non-contact and high-resolution imaging method. Cirrus HD OCT Model 500 (Carl Zeiss Meditec, Dublin, CA) is a spectral domain OCT with superluminescent diode laser of 840 nm wavelength and scan speed of 27000–68000 A- scans per second having A- Scan depth of 2 mm. Cirrus HD OCT has axial resolution of 5 µm and transverse resolution of 15 µm.

Definitions of AS-OCT parameters and measurements

By marking the scleral spur and angle recess by the operator, AS-OCT machine automatically measures the angle parameters such as central corneal thickness (CCT), AC area (ACA), and AC angles (AAs) both nasal and temporal. The AA (i.e., the trabecular iris angle) is measured by placing the angle's apex in the iris recess, its arm at a point on trabecular meshwork 500 µm from the scleral spur and the other arm is placed on the iris at a point perpendicularly opposite to the first point.

AC depth (ACD) is taken as the perpendicular distance between the corneal endothelium at the apex of cornea and anterior surface of lens.

The AC width (ACW) is measured using the built-in chamber tool placing one line horizontally and end points manually adjusting between the opposing scleral spurs.[5] Scans that did not show scleral spur were not included in the study. A single ophthalmic technician performed the measurements in a semi-lit room with patient in seated position.

AS-OCT images were assessed in two quadrants, that is, nasal and temporal. The eyelids were retracted gently during imaging to prevent unintentional pressure on the globe. Image with low signal strength was eliminated. Eyes with corneal pathology, pterygium, post-iridotomy, or poor visualization of scleral spur were excluded from the study. One eye was evaluated for those patients (n = 7).

Statistics

Biometric data were entered in Microsoft Excel (Office 2019) and SPSS software (version 22.0) was used for statistical analysis. Mean ± standard deviation was used to express quantitative variable data. The patients were separated into seven groups based on their age for the ease of statistical analysis, namely, ≤20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, and ≥71 years. AA were divided into five grades as 0°, ≤10°, 11°–20°, 21°–35°, and 36°–45° based on Shaffer grading.[6] Both nasal and temporal angles were included in the study.

RESULTS

Three hundred and forty-nine eyes of 178 patients were analyzed. One hundred and six of them were female (59.55%) and 72 were male (40.45%). The average age of study population was 41.31 ± 13.61 years. [Table 1] shows the parameters of AC measured. [Figures 1-4] shows mean of anterior chamber area, anterior chamber depth, anterior chamber width and central corneal thickness distribution according to age respectively. Among the 698 AA values (including both nasal and temporal angles), 419 (60%) were open angles, 219 (31.37%) were narrow angles and 60 (8.60%)

Table 1: Parameters of anterior chamber.

Parameters	Right eye	Left eye
CCT (µm)	540.85±39.99	536.44±41.25
ACD (mm)	2.37±0.5	2.45±0.4
AC Area (mm²)	17.04±5.20	17.48±4.47
AC Angle nasal (degree)	22.23±14.57	24.14±14.10
AC Angle temporal (degree)	25.18±14.13	25.88±13.55
ACW (in mm)	11.10±0.45	14.13±0.39

CCT: Central corneal thickness, ACD: Anterior chamber depth, AC: Anterior chamber, ACW: Anterior chamber width

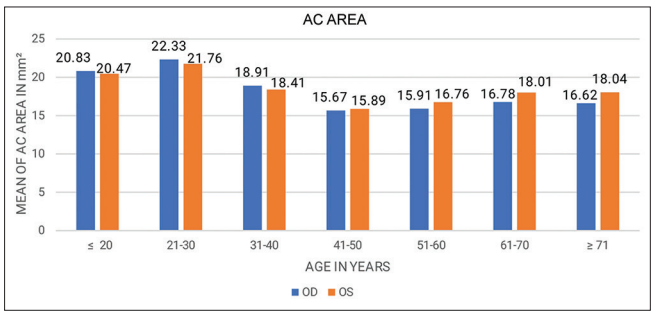

Figure 1: Mean of anterior chamber area distribution according to age.

were closed angles. The AA grading according to the Shaffer classification of AA are given in [Table 2] (right eye) and [Table 3] (left eye). [Figure 5] shows the angle distribution according to Shaffer classification of entire study population. Distribution of CCT values, ACD, ACA, and ACW according to age groups for the right and left eyes is given in [Tables 4 and 5], respectively.

The mean angles in PACG and PAC, PACS, POAG, and GS in our study are 3.73° ± 3.9°, 6.76° ± 2.66°, 33.59° ± 9.15°, and 22.66° ± 9.46°, respectively. [Figure 6] shows AS-OCT image of a closed angle. [Figure 7] shows AS-OCT image of a narrow angle with ruler showing CCT (513 μm), ACD (1.85 mm), Lens Vault (1115 μm) and ACW (11.14 mm). [Figure 8] shows AS-OCT image of an open angle with angle parameters.

While analyzing the nasal and temporal angles in both eyes, the nasal angle was found to be narrower than the temporal angle. The mean nasal angle in the right eye was 22.23° ± 14.57° and temporal angle was 25.18° ± 14.14° ($P < 0.001$) and in the left eye, the nasal was 24.14° ± 14.10° versus temporal 25.88° ± 13.55° ($P < 0.05$). [Figures 9 and 10] shows the mean anterior chamber angle distribution according to age of left and right eye respectively. The study also revealed that the difference between nasal and temporal angles was more in older age groups, that is, >50 years (5.78° ± 5.64° for the right eye and 5.16° ± 4.22° for the left eye) as compared to younger age groups, that is, <50 years (5.32° ± 4.82° for the right eye and 4.77° ± 4.92° for the left eye).

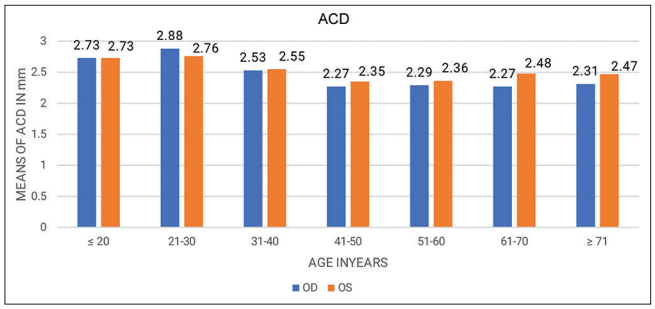

Figure 2: Mean of anterior chamber depth distribution according to age.

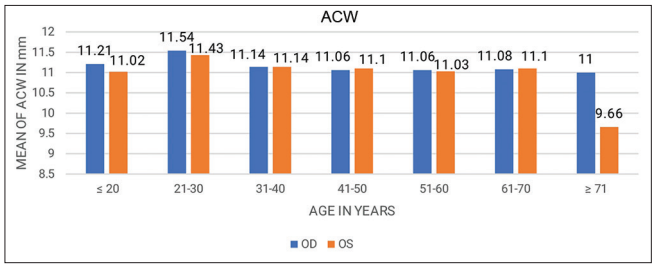

Figure 3: Mean of anterior chamber width distribution according to age.

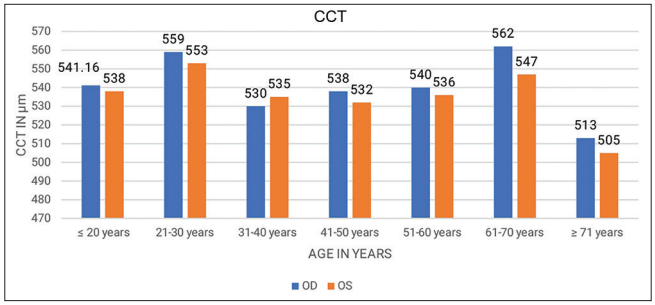

Figure 4: Mean of central corneal thickness distribution according to age.

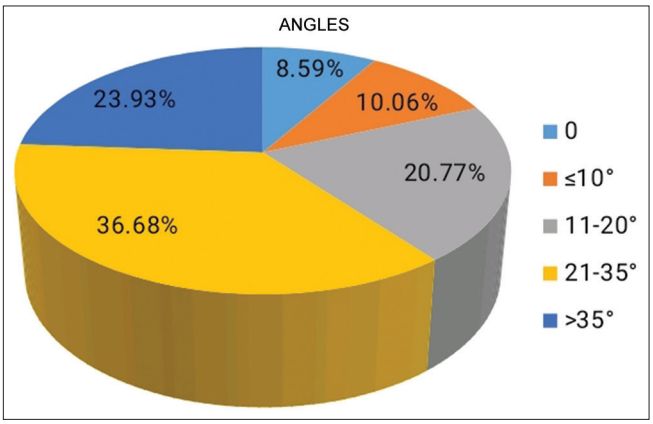

Figure 5: Pie chart of angle distribution.

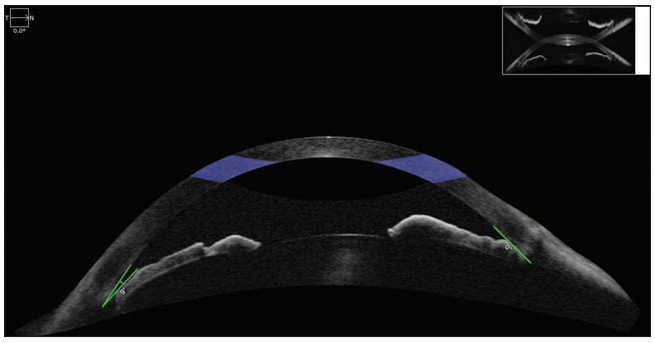

Figure 6: Image depicting angle closure.

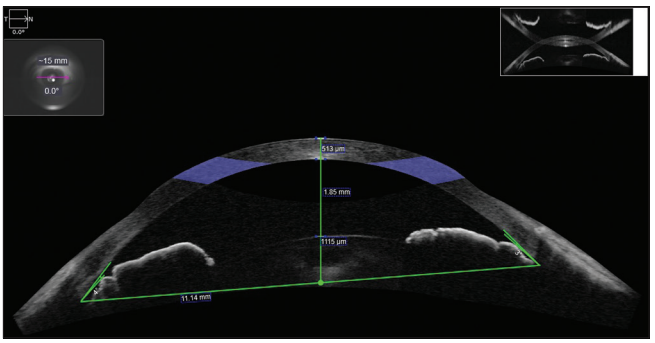

Figure 7: Image depicting narrow-angle.

Table 2: Angle grading of male and female right eye.

Right eye nasal angle	Male	Female	Total	Right eye temporal angle	Male	Female	Total
0°	5	16	21	0°	6	7	13
≤10°	2	17	19	≤10°	2	17	19
11–20°	16	26	42	11–20°	8	24	32
21–35°	25	33	58	21–35°	29	40	69
>35°	22	13	35	>35°	25	17	42

Table 3: Angle grading of male and female left eye.

Left eye nasal angle	Male	Female	Total	Left eye temporal angle	Male	Female	Total
0°	4	12	16	0°	3	7	10
≤10°	5	16	21	≤10°	4	11	15
11–20°	4	28	32	11–20°	9	30	39
21–35°	31	31	62	21–35°	23	40	63
>35°	26	17	43	>35°	31	16	47

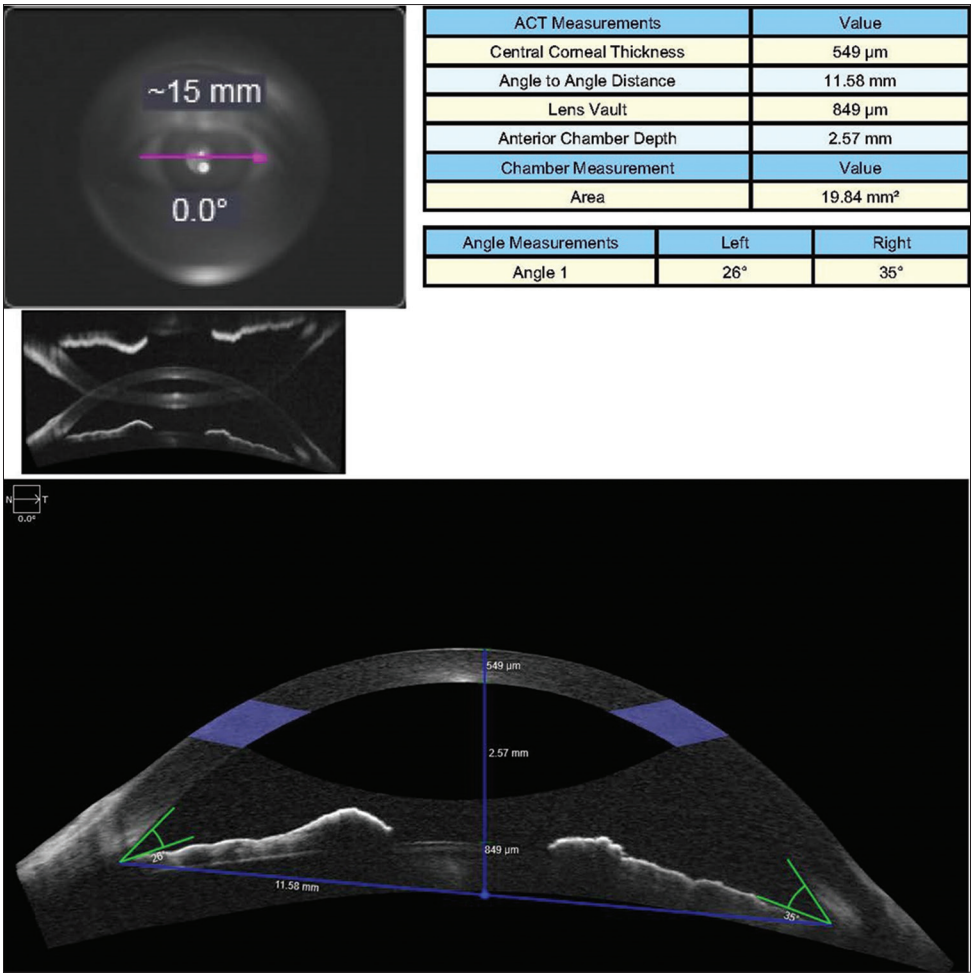

Figure 8: Wide-angle with angle parameters.

Table 4: Right eye parameters.

	CCT in µm	ACD in mm	AC-area in mm²	AC-nasal in degree	AC-temporal in degree	ACW in mm
≤20 years						
Male 2	544±42.4	2.90±0.13	22.86±0.07	42.5±10.60	39.5±2.12	11.39±0.06
Female 4	539.7±32.10	2.64±0.53	19.82±0.39	31.5±15.45	33.25±14.81	11.13±0.54
21–30						
Male 8	567±43.27	2.76±0.24	22.31±3.73	36.5±11.09	38.75±10.49	11.57±0.34
Female 2	531±65.76	2.87±0.19	22.43±1.47	39±5.65	45±5.65	11.42±0.53
31–40						
Male 13	537±41.06	2.58±0.38	19.79±4.74	29.91±19.81	29.58±19.44	11.24±0.42
Female 15	524.1±40.15	2.49±0.40	18.20±3.49	24.61±12.11	28.86±9.77	11.06±0.40
41–50						
Male 11	527.2±28.6	2.47±0.72	18.18±7.08	23.72±16.48	29.27±17.39	11.35±0.51
Female 38	541.6±28.65	2.22±0.43	14.95±3.91	14.73±10.17	18.76±12.10	10.98±0.33
51–60						
Male 21	536.3±31.37	2.34±0.54	16.14±6.00	23.33±11.93	23.09±13.23	11.12±0.59
Female 29	544.2±35.61	2.24±0.43	15.73±4.08	17.10±13.64	21.50±11.7	11.02±0.38
61–70						
Male 9	556.8±78.22	2.67±0.31	20.82±3.58	32.87±12.63	33.25±8.43	11.45±0.31
Female 17	564.5±49.02	2.09±0.65	14.87±6.19	19.82±14.42	21.88±13.33	10.90±0.49
≥71						
Male 8	518.3±27.28	2.35±0.39	17.15±5.24	23.37±13.92	26.25±15.06	11.01±0.49
Female 1	476	2.02	12.37	0	0	10.93

CCT: Central corneal thickness, ACD: Anterior chamber depth, AC: Anterior chamber, ACW: Anterior chamber width

Table 5: Left eye parameters.

	CCT in µm	ACD in mm	AC-area in mm²	AC-nasal in degree	AC-temporal in degree	ACW in mm
≤20 years						
Male 2	546±11.3	2.83±0.07	21.85±0.31	40±9.8	32.5±9.19	11.52±0.02
Female 4	534.5±36.29	2.68±0.39	19.79±3.64	36.75±26.99	39.5±15.84	10.77±0.71
21–30						
Male 8	558.7±43.27	2.71±0.22	21.42±1.77	38.57±9.48	38.14±10.15	11.52±0.35
Female 2	536±29.69	2.94±0.19	22.93±1.03	46±8.48	41.5±12.02	11.09±0.12
31–40						
Male 13	534.5±37.77	2.69±0.31	20.27±3.87	31.46±14.4	32.07±14.48	11.25±0.38
Female 15	536.8±91.91	2.43±0.37	16.80±4.46	20.4±13.31	26.06±7.56	11.04±0.38
41–50						
Male 11	519.1±29.06	2.62±0.46	19.36±5.40	23.45±16.89	27.18±19.36	11.35±0.54
Female 38	536.4±28.69	2.27±0.37	14.88±3.53	16.05±11.22	17.21±15.5	11.03±0.40
51–60						
Male 21	532.7±30.32	2.42±0.51	17.41±4.86	24.57±11.90	27.23±12.89	11.02±0.78
Female 29	538.8±29.20	2.32±0.37	16.28±4.04	19.39±11.77	21.42±10.97	11.04±0.49
61–70						
Male 9	548.7±50.33	2.62±0.41	19.38±4.54	32.22±12.23	30.77±12.23	11.41±0.33
Female 17	547.3±29.76	2.40±0.39	17.25±3.99	19.82±14.42	27.93±11.31	10.93±0.45
≥71						
Male 8	512.2±31.66	2.54±0.35	19.54±4.14	33.28±10.90	30.57±10.93	9.49±3.80
Female 1	459	1.93	7.57	0	0	10.87

CCT: Central corneal thickness, ACD: Anterior chamber depth, AC: Anterior chamber, ACW: Anterior chamber width

DISCUSSION

Identifying the scleral spur is critical for proper angle biometry assessment, as the angle measurement is dependent on it entirely.[7] To measure the angle parameters, the angle recess and scleral spur are manually marked by the observer. A scleral spur is a point where sclera protrudes inward and the inner surface of sclera changes in curvature.

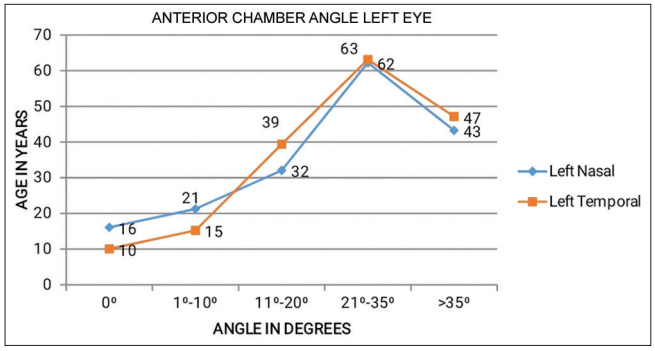

Figure 9: Mean of the left eye anterior chamber angle distribution according to age.

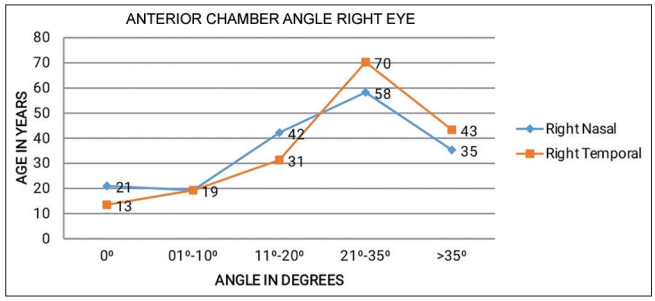

Figure 10: Mean of the right eye anterior chamber angle distribution according to age.

Several techniques, including Van Herrick assessment, gonioscopy, ultrasound biomicroscopy, and AS-OCT, have been described for population-based screening of Primary angle closure disease (PACD).[8-10] A community-based AS-OCT imaging study found that in 22.8% of angles, the scleral spur could not be clearly distinguished.[11] Angle assessment in case of angle closure is widely being done using various types of AS-OCT.[11,12] In this study, we are using Cirrus HD OCT 500 to study the angle parameters.

The mean age of our study population was 41.31 ± 13.61 years lesser than that reported by Angmo *et al.*[7] (59.48 ± 7.95 years), Radhakrishnan *et al.*[13] (60.8 ± 9.8 years), and Lin *et al.*[11] (55.5 ± 9.0 years).

The mean CCT value in our study was 549 ± 41.01 µm which was more than that reported by Angmo *et al.*[7] (522.5 ± 34.75 µm and 539.55 ± 29.56 µm), Malhotra *et al.*[14] (505.97 ± 30.12 µm), Yazici *et al.*[15] (529 ± 30.5 µm), and similar to Bechmann *et al.*[16] (530 ± 32 µm).

The ACD in our study was found to be 2.28 ± 0.34 mm, similar to that reported by Angmo *et al.*[7] (2.144 ± 0.38 mm and 2.133 ± 0.39 mm) and lesser than that of Moghimi *et al.*[12] (2.53 ± 0.28 mm) and Yazici *et al.*[15] (2.94 ± 0.34 mm).

The mean ACA value was found as 15.61 ± 8.17 mm^2 in the present study, lesser than that reported by Wu *et al.*[17] (20.1 mm^2). The mean ACW was 11.29 ± 0.72 mm in our study, similar to Xu *et al.*[18] (11.6 ± 0.39) mm and lesser than Goldsmith *et al.*[19] (12.53 ± 0.47 mm). The study done by Nongpiur *et al.* has reported that when compared with eyes having wide angle, the mean ACW was lesser in eyes with narrow angle (11.80 mm vs. 11.60 mm, $P < 0.001$).[5]

In this study, we have found out that the nasal AA was significantly narrower than the temporal angle in both right and left eyes. Till date, no study has reported AA being narrower nasally than temporally.

Limitation of our study was correlation between the various parameters of AC and AA was not done. The angles were manually measured, which can be a cause of error.

CONCLUSION

In this study, in general non randomized population, it was found that the nasal AA is significantly narrower than the temporal angle in both right and left eyes. It was also observed that the angle asymmetry increases with age in general population.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Allingham RR, Damji KF, Rhee DJ, Moroi SE, Freedman SF, Asrani SG, *et al.*, editors. Shield's Textbook of Glaucoma. 7th ed. United States: Wolters Kluwer Health; 2020.
2. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. Br J Ophthalmol 2002;86:238-42.
3. Tejwani S, Angmo D, Nayak BK, Sharma N, Sachdev MS, Dada T, *et al.* Preferred practice guidelines for glaucoma management during COVID-19 pandemic. Indian J Ophthalmol 2020;68:1277-80.
4. Ahmad SS. Glaucoma suspects: A practical approach. Taiwan J Ophthalmol 2018;8:74-81.
5. Nongpiur ME, Sakata LM, Friedman DS, He M, Chan YH, Lavanya R, *et al.* Novel association of smaller anterior chamber width with angle closure in Singaporeans. Ophthalmology 2010;117:1967-73.
6. Carlesimo SC, Di Santo L, Bruni P, Librando A, Falace AP, Barbato A. Nd: Yag laser iridotomy in Shaffer-Etienne grade 1

and 2: Angle widening in our case studies. Int J Ophthalmol 2015;8:709-13.
7. Angmo D, Singh R, Chaurasia S, Yadav S, Dada T. Evaluation of anterior segment parameters with two anterior segment optical coherence tomography systems: Visante and Casia, in primary angle closure disease. Indian J Ophthalmol 2019;67:500-4.
8. Liang Y, Friedman DS, Zhou Q, Yang XH, Sun LP, Guo L, *et al*. Prevalence and characteristics of primary angle-closure diseases in a rural adult Chinese population: The Handan Eye Study. Invest Ophthalmol Vis Sci 2011;52:8672-9.
9. Halawa OA, Zebardast N, Kolli A, Foster PJ, He M, Aung T, *et al*. Population-based utility of van Herick grading for angle-closure detection. Ophthalmology 2021;128:1779-82.
10. Lavanya R, Foster PJ, Sakata LM, Friedman DS, Kashiwagi K, Wong TY, *et al*. Screening for narrow angles in the Singapore population: Evaluation of new noncontact screening methods. Ophthalmology 2008;115:1720-7, 1727.e1-2.
11. Lin S, Hu Y, Ye C, Congdon N, You R, Liu S, *et al*. Detecting eyes with high risk of angle closure among apparently normal eyes by anterior segment OCT: A health examination center-based model. BMC Ophthalmol 2022;22:513.
12. Moghimi S, Chen R, Hamzeh N, Khatibi N, Lin SC. Qualitative evaluation of anterior segment in angle closure disease using anterior segment optical coherence tomography. J Curr Ophthalmol 2016;28:170-5.
13. Radhakrishnan S, See J, Smith SD, Nolan WP, Ce Z, Friedman DS, *et al*. Reproducibility of anterior chamber angle measurements obtained with anterior segment optical coherence tomography. Invest Ophthalmol Vis Sci 2007;48:3683-8.
14. Malhotra C, Gupta B, Dhiman R, Jain AK, Gupta A, Ram J. Corneal and corneal epithelial thickness distribution characteristics in healthy North Indian eyes using spectral domain optical coherence tomography. Indian J Ophthalmol 2022;70:1171-8.
15. Yazici AT, Bozkurt E, Alagoz C, Alagoz N, Pekel G, Kaya V, *et al*. Central corneal thickness, anterior chamber depth, and pupil diameter measurements using Visante OCT, Orbscan, and Pentacam. J Refract Surg 2010;26:127-33.
16. Bechmann M, Thiel MJ, Neubauer AS, Ullrich S, Ludwig K, Kenyon KR, *et al*. Central corneal thickness measurement with a retinal optical coherence tomography device versus standard ultrasonic pachymetry. Cornea 2001;20:50-4.
17. Wu RY, Nongpiur ME, He MG, Sakata LM, Friedman DS, Chan YH, *et al*. Association of narrow angles with anterior chamber area and volume measured with anterior-segment optical coherence tomography. Arch Ophthalmol 2011;129:569-74.
18. Xu BY, Lifton J, Burkemper B, Jiang X, Pardeshi AA, Moghimi S, *et al*. Ocular biometric determinants of anterior chamber angle width in Chinese Americans: The Chinese American Eye Study. Am J Ophthalmol 2020;220:19-26.
19. Goldsmith JA, Li Y, Chalita MR, Westphal V, Patil CA, Rollins AM, *et al*. Anterior chamber width measurement by high-speed optical coherence tomography. Ophthalmology 2005;112:238-44.

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