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Sara Salah Abd Elrahman Dabour
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Ahmed Fekry Almaria
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Tarek Ragaie Hussien
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Tarek El-Mohammadi Eid
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Corresponding Author:
Sara Salah Abd Elrahman Dabour
Department of Ophthalmology, Faculty of Medicine, Tanta University, Tanta, Egypt

Anterior segment optical coherence tomography parameters in subtypes of primary angle closure glaucoma

Sara Salah Abd Elrahman Dabour, Ahmed Fekry Almaria, Tarek Ragaie Hussien and Tarek El-Mohammadi Eid

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Abstract

Background: Anterior segment optical coherence tomography (AS-OCT) offers a non-contact method for high resolution cross-sectional imaging of the anterior segment and its structures by measuring their optical reflections. This project's objective was to research the significant value of AS-OCT parameters in subtypes of primary angle closure glaucoma (PACG).

Methods: This is an observational, prospective cross-sectional research on 60 eyes of patients with PACG. There were three distinct groups of patients: Group (PACS) (n=18): primary angle closure suspect. Group (PAC) (n=18): primary angle closure. Group (PACG) (n=24): PACG

Results: Angle Opening Distance (AOD) 500 NAS and Trabecular-Iris Contact Length (TICL) NAS discrepancies across the groups (p1, p2 and p3) were statistically different. In the group P1, there were substantial variations in iris thickness measured by the 750 Trabecular Meshwork (TEM). In the PACG and PAC groups, respectively, there was a highly significant negative connection between the lens vault and the AC depth and width. The lens vault and TICL at the temporal angle had a substantial negative association in the PAC group and an elevated correlation in the PACG group. Cup-to-disc (C/D) ratio, lens vault, AOD500 at nasal angle, Iris curve at nasal and temporal angle, Iris thickness at temporal angle, TICL at both temporal and nasal angle are predictor parameters in subtypes of primary angle closure.

Conclusions: ASOCT can be used to assess anterior chamber angle. AS-OCT has a role to determine which parameters are the strongest predictive factors of subtypes of PAC. AS-OCT will be employed as a diagnostic tool for glaucoma patients' diagnosis and maybe their therapy.

Keywords: Anterior segment optical coherence tomography, primary angle closure glaucoma

Introduction

Intra ocular pressure is a significant modifiable risk factor for glaucoma, an optic neuropathy that features distinctive optic disc destruction, progressive loss of retinal ganglion cells, and impairment of field of vision [1].

Open-angle glaucoma and closed-angle glaucoma are two of the general categories of glaucoma [2].

Anatomical ailment known as angle closure disease prevents aqueous drainage via the trabecular meshwork due to iris-trabecular contact [3].

Despite the fact that pupillary block and plateau iris syndrome are the two principal steps in the pathogenesis of the primary angle closure disease (PACG), extra iris, lens, and ciliary body-related variables also play important roles [4].

When identified before irreversible harm to the optic nerve or trabecular meshwork, primary angle closure glaucoma, one of the major causes of blindness in the world, may be curable [5]. The most frequent clinical test used to assess the Anterior Chamber Angle for both diagnosis and initial managing is a gonioscopy [6, 7].

By spotting the optical reflection of the anterior segment and its constituent parts, anterior segment optical coherence tomography (AS-OCT) provides a non-contact approach for high resolution cross-sectional imaging of the anterior segment and its elements [8].

The advent of AS-OCT has allowed for the visualization of the whole anterior segment in a single picture as well as the evaluation of angle, iris, and lens parameters [9].

Angle closure has been linked to AS-OCT based metrics such the lens vault, anterior chamber size, anterior chamber breadth, and iris thickness [10, 11].

This research sought to figure out the value of AS-OCT features in various kinds of primary angle closure glaucoma.

Patients and Methodology

This prospective, observational cross-sectional investigation involved 60 individuals with primary angle closure glaucoma and was done on their eyes.

After receiving approval from the Ethical Committee Tanta University Hospitals, the study was carried out from January 2021 to December 2021. The patients provided signed consent after being fully briefed.

Exclusion criteria were history of intraocular surgery including acute primary angle closure glaucoma, prior ocular injuries, laser peripheral iridotomy, any anterior segment abnormalities that would preclude OCT imaging of the angle such as a dense corneal arcus or pterygium, eyes with secondary cause of angle closure such as (neovascular, iridocorneal endothelial syndrome, malignant glaucoma, etc).

Patients were divided in to three groups:

Group (PACS) (n=18)**:** Eyes with narrow angles (defined as eyes in which at least 180 degrees of the posterior pigmented trabecular meshwork was not apparent on gonioscopy in the primary position of gaze lacking indentation) that possess an IOP of less than or equal to 21 mm Hg, a healthy optic disc, and no PAS are primary angle closure suspects [12].

Group (PAC) (n=18)**:** eyes with narrow angles, healthy optic discs, and normal visual fields but high IOP > 21 mm Hg and/or PAS are said to have primary angle closure [12].

Group (PACG) (n=24)**:** Eyes with high IOP, PAS with glaucomatous optic neuropathy (defined as vertical CDR 0.7, CDR asymmetry > 0.2, and/or specific notching), and glaucomatous visual field alterations are the hallmarks of primary angle closure glaucoma [12].

All patients were subjected to full ophthalmology examination including Visual acuity (UCVA) and BCVA (corrected visual acuity).

Slit lamp biomicroscopy assessment of the anterior section: Corneal examination for presence or absence of corneal edema, opacity, examination of the iris for detection of patches of iris atrophy or presence of neovascularization, pupil examination for its shape, reactivity and regularity.

Evaluation of peripheral ACD through the Van Herick method[13]: This procedure is carried out solely with a slit light. It entails projecting a thin slit of light from a slit lamp onto the peripheral cornea at an angle of 600, as close to the limbus as feasible, while employing the width as a benchmark to assess the angle.

Grade 3 ACD > 25 to 50% and the angle cannot be closed; Grade 2 ACD 25% and the angle closure is possible; Grade 1 ACD 25%; Grade 4 ACD 100% of corneal thickness and the angle is widely open [13].

Gonioscopy (using Goldmann 3 Mirror goniolens): One drop of local anesthetic (0.4%noxinate hydrochloride) was administered to the eye by instilling 2.5% methylcellulose into the cavity of the gonioscopy lens to secure the lens to the lower edge of the eye bag. . . , the patient was asked to look up when the lens was placed in the eye, the evaluation began with the mirror at the 6 o'clock position, rotated to identify angular structures in all quadrants, the angular classes were classified according to the Shaffer grade., depending on the visibility of the angular structures and the numerical degree (0-4) rating of each angle

Grade 3 (25-35 degrees): Scleral spur can be seen; it is also impossible of closure. Grade 2 (20 degrees): Only trabeculae can be seen; the angle is relatively thin; closure is feasible. Grade 1 (10 degrees): Only Schwalbe's line is visible; the angle is extremely narrow; closure risk is significant. Grade 0 (zero degree): Closed angle as a result of Iris.

Using a Zeiss 4 mirror lens, dynamic gonioscopy (indentation) was performed following static gonioscopy to distinguish between appositional and synechial angle closure. Aqueous humour was compelled into the chamber angle while the cornea was subjected to light pressure. If there was contact or apposition between the irido-trabecular layers, the angle would expand, and the structures would become clearer.

Fundus examination with 90D lens: Done by slit-lamp by using 90D lens. The slit lamp allows to see the retina, optic disc and other structures inside the eye in great detailed view. Both static and dynamic gonioscopy and anterior chamber grading was done by the supervisor (Fekry A) before examining the angle with anterior segment OCT.

The AS-OCT tool applied in this investigation was the Tokyo, Japan-made Topcon DRI OCT Triton.

After the clinical assessment completed, the AC angle was imaged by optical coherence tomography: An anterior segment module lens was set up and a head rest attachment was employed as sitting to offer AS-OCT imaging of the nasal and temporal angle quadrants. Imaging was performed in slightly dim light room conditions was the same for every patient (to avoid constriction of the pupil with bright illumination or dilatation in darkened room). The patients were asked to look straight ahead to an external fixation light. Imaging of a single 3mm vertical line scan of the anterior chamber angle at 3 and 9 o'clock positions was performed.

The position of the scleral spur has been established through the following methods [14]: Outline with a peak with greater contrast than the ciliary body, as a projection into the anterior chamber posterior to the trabecular meshwork, as an inward protrusion linked to a change in the internal curvature of the sclera, as the internal point of a line splitting the CM and sclera.

After the SS's location was established and measurements of the anterior chamber's breadth and depth, angle opening distances at 500 m and 750 m from the scleral spur were obtained, and the angle was quantitatively assessed. Figure 1.

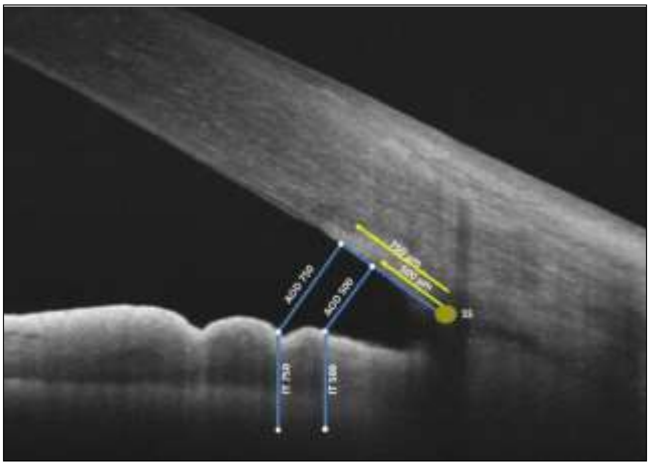


Fig 1: AOD500, AOD750, IT750.

The gap between the anterior lens surface and the line horizontally linking the two scleral spurs is referred to as the lens vault.

The maximum perpendicular distance from a line drawn from the iris pigment epithelium's most periphery and most central positions to the iris pigment epithelium is employed for the calculation of the iris curve [15].

A measurement of the trabecular-iris contact length (TICL) and iris thickness (IT750) anterior to the scleral spur were made.

Statistical analysis

IBM, Illinois, Chicago, USA, applied SPSS v21 to conduct the statistical study. One-sample Kolmogorov—Smirnov test to determine whether the data are normal. For non-parametric data, the median as well as the range, mean, and standard deviations were determined for numerical values. The One-way Anova test (ANOVA) was used for contrasting two mean values for parametric data, while Kruskal Wallis was employed with non-parametric data. Dunn's multiple comparisons test, or Post Hoc Test, was implemented to determine relevance across groups. For categorical variables, the number and percentage were computed, and the chi square test was used to see whether there were any differences across subcategories. The correlation between the variables was determined using Pearson's correlation coefficient (r). In order to identify the predictor variables for the risk estimate, linear regression was applied. Level of significant was adopted at $p<0.05$.

Results:

Table 1 displays the research groups' demographic data.

Table 1: The research groups' demographics

Variable		PACS (No.= 18)	PAC (No.= 18)	PACG (No.=24)	*p*<value
Age	Range	25-59	25-65	22-71	F (0.958)
	Mean ± SD	50.56±10.91	50.89±15.16	55.58±13.55	P (0.390)
Sex	Male	4 (22.2%)	6 (33.3%)	15 (62.5%)	X^2 (7.600)
	female	14(77.8%)	12 (66.7%)	9 (37.5%)	P (0.022*)

Data are presented as mean ± SD or frequency (%)

IOP using the gold standard Goldmann applanation tonometer of the study eyes had a mean value of 16.67 ± 2.61, 21.94 ± 4.56 and 22.83±7.55 mmHg in PACS, PAC, and PACG respectively. IOP measurements were significantly lower in eyes with PAC and PACS than those of PACG (P=0.009*). Figure 2

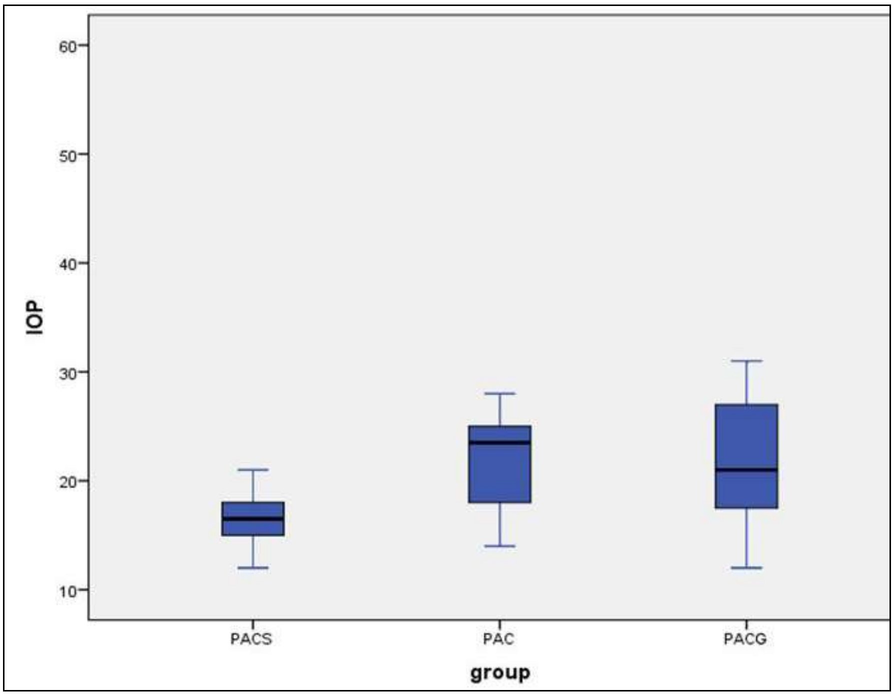


Fig 2: Distribution of IOP measured in the studied groups

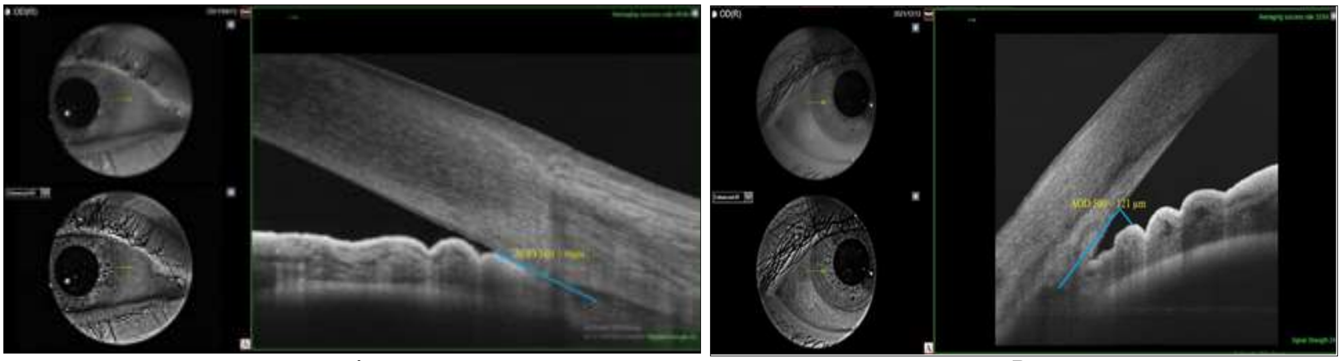
There were statistically substantially importance in AOD 500 NAS among the groups (p1, p2 and p3) Table 2

Table 2: Angle opening distance 500µm NAS, range, mean, SD and its significance of difference in the study groups:

AOD 500 µm NAS	PACS (No.= 18)	PAC (No.= 18)	PACG (No.=24)
Range µm	58 – 195	0 – 173	0 - 110
Mean ± SD µm	113.39±38.01	47.06±61.42	13.42±30.16
Test of sig.	Kruskal wallis test		
P value	0.000*		
Mann-Whitney U test	P1	P2	P3
P value	0.002*	0.000*	0.020*

Data are presented as mean ± SD or Range. AOD: Angle Opening Distance P1: PACS versus PAC, P2: PACS versus PACG, P3: PAC versus PACG

There was statistically significant differences in AOD 500 TEM among the groups (p1, p2 and p3). Figure 3



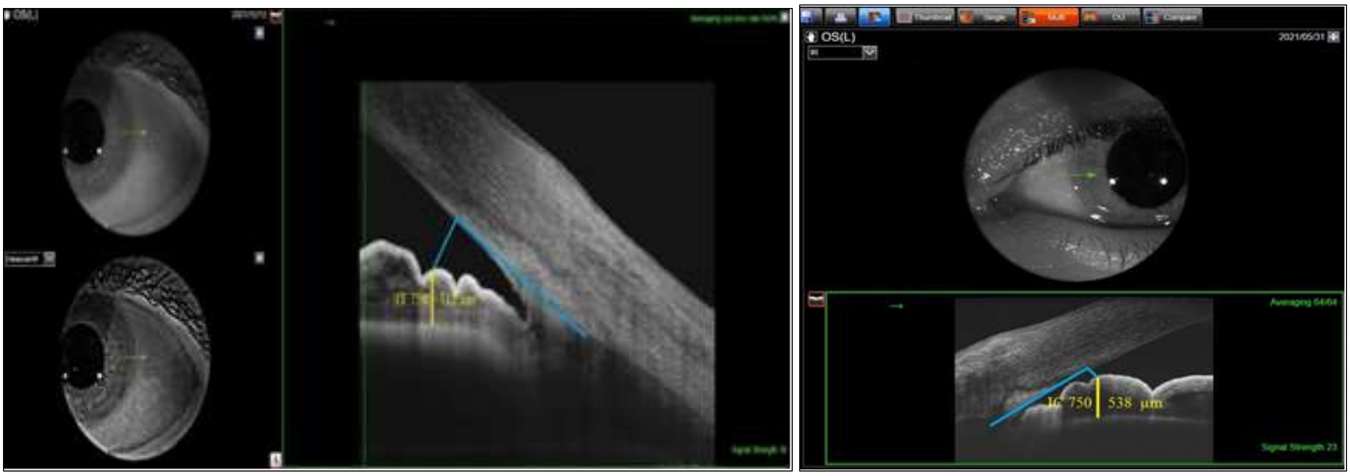
A B

Fig 3: (A)AOD 500 was totally closed, was measured 0 µm in case of PACG, (B) AOD 500 was measured 121 µm in case of PAC.

Table 3: Iris thickness 750 TEM ranges, mean, SD and its significance in the groups:

	PACS (No.= 18)	PAC (No.= 18)	PACG (No.=24)
Range µm	217- 602	281 – 474	220 - 555
Mean ± SD µm	373.44 ± 54.00	373.44 ± 54.00	358.42 ± 91.81
Test of sig.	Kruskal- wallis		
P value	0.038*		
Mann-Whitney U test	181.000	153.000	79.000
P value	0.009*	0.109	0.374

Data are presented as mean ± SD or Range P1: PACS versus PAC, P2: PACS versus PACG, P3: PAC versus PACG



A **B**

Fig 4: IT 750 was measured (A) 312 µm in case of PAC, (B) 538 µm in case of PACS.

A **B**

Fig 5: (A) TICL was measured 997 µm in case of PACG. (B) Temporal angle in case of PACS showed no TICL

Table 4: Trabecular iris contact length (TICL) NAS range, mean, SD and its significance in the groups:

TICL NAS	PACS (No.= 18)	PAC (No.= 18)	PACG (No.=24)
Range µm	**0 – 20**	**0 - 630**	**0 - 1054**
Mean ± SD µm	2.50 ± 6.00	173.50 ± 209.84	414.00 ± 308.69
Test of sig.	Kruskal- Wallis		
P value	0.000*		
Mann-Whitney U test	P1	P2	P3
P value	0.000*	0.000*	0.004*

Data are presented as mean ± SD or Range P1: PACS versus PAC, P2: PACS versus PACG, P3: PAC versus PACG

Table 5: Correlation between lens vault and other AS- OCT angle parameters among the studied patients

	Lens vault					
	PACS (No.= 18)		PAC (No.= 18)		PACG (No.=24)	
	r	P	r	p	r	P
Iris curve NAS	0.348	0.157	0.144	0.568	-0.167	0.436
Iris curve TEM	0.255	0.307	-0.015	0.954	-0.088	0.682
AC depth	-0.104	0.680	0.251	0.315	-0.458	0.024*
ACW	0.139	0.581	-0.593	0.010*	-0.077	0.722
AOD500NAS	- 0.076	0.764	-0.024	0.926	0.029	0.892
AOD500TEM	0.042	0.870	0.370	0.131	-0.153	0.476
AOD750 NAS	0.004	0.989	-0.428	0.076	0.015	0.944
AOD 750TEM	-0.065	0.797	-0.095	0.707	-0.158	0.460
TICL NAS	0.140	0.580	0.093	0.713	0.037	0.862
TICL TEM	0.253	0.654	-0.713	0.001*	0.428	0.037*

Table 6: Stepwise linear regression analysis of predictor variables affecting PACG:

Model	Standardized Beta	t	Sig.
Age	0.086	1.268	0.210
Sex	-0.044	-0.617	0.540
UCVA	0.040	0.466	0.643
BCVA	-0.032	-0.357	0.723
VANHERICK	-0.014	-0.152	0.880
IOP	-0.041	-0.533	0.597
C/D Ratio	2.63	8.12	0.001*
ACW	-0.078	-1.157	0.252
ACD	-0.059	-0.844	0.403
Lens vault	0.047	0.652	0.012*
AOD 500TEM	-0.180	-1.762	0.084
AOD500NAS	0.67	-6.62	0.001*
AOD 750NAS	0.045	0.517	0.607
AOD 750TEM	-0.044	-0.491	0.625
Iris curve NAS	1.042	5.589	0.001*
Iris curve TEM	2.050	6.672	0.005*
IT750NAS	0.67	0.132	0.065
IT750TEM	2.33	7.176	0.041*
TICLNAS	0.090	1.980	0.032*
TICLTEM	0.002	0.018	0.002*

Table 7: Multinomial logistic regression for predictor factors affection PACG:

Variables	B	Wald	Sig.	95% Confidence Interval for Exp(B)	
				Lower Bound	Upper Bound
LENS VAULT	0.004	7.973	0.581	-0.013-	-0.002-
AOD 500µm NAS	-0.031-	1.841	0.005*	-0.007-	0.039
AOD 500 µm TEM	-0.001-	0.381	0.175	-0.016-	0.030
AOD 750 µm NAS	0.021	1.550	0.537	-0.040-	0.009
AOD750 µm TEM	-0.038-	3.329	0.213	-0.002-	0.055
Iris curve NAS	-0.018-	0.310	0.068	-0.016-	0.028
Iris curve TEM	0.012	0.014	0.578	-0.019-	0.017
IT 750 NAS	-0.007-	4.937	0.907	-0.028-	-0.002-
IT 750 TEM	-0.026-	7.793	0.026*	0.007	0.041
Trabecular iris contact length NAS	0.008	2.488	0.005*	-0.014-	0.002
Trabecular iris contact lens TEM	0.003	1.058	0.115	-0.018-	0.006

TICL NAS showed important statistical variations (P = 0.000*) among the groups (p1, p2, and p3). Table 4

In the PACG group, there was a sizable negative connection between the lens vault and the AC depth. In the PAC group, there was a substantial inverse relationship between lens vault and AC width.

In the PAC group, there was a substantial inverse connection between the lens vault and TICL at the temporal angle, but in the PACG group, there was a significant inverse correlation. Table 5.

Cup-to-disc (C/D) ratio, lens vault, AOD500 at nasal angle, Iris curve at nasal and temporal angle, Iris thickness at temporal angle, In certain subtypes of primary angle closure, TICL at the temporal and nasal angles is a predictive measure. Table 6

AOD 500 at nasal angle, Iris thickness at temporal angle, Predictor variables in main angle closure subtypes include TICL at the nasal angle. Table 7

Discussion

Accurate angle assessment is crucial when establishing a diagnosis and selecting how to manage people with angle closure [16].

Based on the present study's demographic data, PACS group was more prevalent in females than males. Also, PAC group was more prevalent in females than male, while PACG group was more prevalent in males than females.

Xu *et al*., [17] study that found that 160 participants were men, and 527 participants were woman.

Regarding AOD 500 µm. There were statistically noteworthy variations among the total groups at the nasal and temporal angles of the eye, this finding was consistent with Xu *et al*., [17] study that showed significant differences for AOD500 among the studied group.

Measurements of AOD 750 µm at temporal angle in our study, were statistically significant different among the whole groups, while AOD 750 µm at nasal angle, were statistically significant different among PACS versus PACG and PAC versus PACG, except between PACS versus PAC. This result agreed with Nongpiur *et al*., [18] study that showed AOD750 had a statistically significant difference.

Also, Narayanaswamy *et al*., [19] study that showed AOD750 was the most describing measurement for narrow angles by sensitivity (82.5% and 90.2%) and specificity (84% and 77.4%) on cut off values of (225 and 258 µm) in the temporal & nasal angles respectively.

Regarding Iris curvature at nasal angle, there were quantitatively substantial variations between the groups in the current investigation regarding PAC and PACG. Also, iris curvature at temporal angle had statistically significant differences between PAC and PACG and borderline statistically differences between PACS and PACG. This result was partially consistent with Xu, *et al*., [17] study that showed statistically significant differences of iris curvature measurements.

Measurements of iris thickness 750 at both nasal and temporal angle were statistically significant different only among PACS versus PAC groups. Between the PACS and PACG group, there were no noticeable differences. The findings of Moghimi *et al*.'s [20] investigation, which revealed no statistically significant variation in the mean IT750 across the three groups of companion eyes—AAC, PACG, and PACS—were corroborated by this result.

Regarding Trabecular iris contact length at both nasal and temporal angle, the groups PACS, PAC, and PACG have substantial variations from one another.

This result agreed with Melese *et al*., [21] study that assessed TICL in the four angle quadrants and approved its significance in the nasal and temporal angle quadrants with sensitivity (89% and 86%) and specificity (90% and 88%) in both angles respectively. Also Radhakrishnan *et al*., [22] study that showed TICL was used as a new parameter for defining AC angle anatomy however it has low sensitivity (62.5%) but showed perfect specificity (100%) in detecting angle closure.

We discovered a significant inverse relationship between lens vault and all of the ACD in the PACG group, the ACW in the PAC group, and the TICL at the temporal angle in the PAC group (p=0.024*). Additionally, in the PACG group, there was a highly significant positive connection between lens vault and TICL at the temporal angle. This was confirmed in Moghimi *et al*., [20] study that independent of the quantity of PAS, a substantial negative connection between lens vault and ACD was discovered.

Also, Moghimi *et al*., [20] Lens vault was discovered to have a weakly positive link with iris curvature, which did not overlap with the current study, and a substantially negative correlation with AOD500 across all analyzed groups.

However, In the PACS, PAC, and PACG groups, there was no discernible relationship between the iris curve at the nasal and temporal angle and the lens vault, also there was no significant correlation between lens vault and AC width in PACS and PACG groups and there were no significant correlations between lens vault and AOD500 NAS, AOD 500 TEM, AOD 750 NAS, AOD 750 TEM and TICL NAS in PACS, PAC, PACG groups.

Stepwise linear regression analysis was carried out to know the predictive factors of PACG and it showed that C/D ratio, lens vault, AOD500 at nasal angle, iris curve at nasal and temporal angle, iris thickness at temporal angle, TICL at both temporal and nasal angle were the strongest predictive parameters of subtypes of PAC.

Additionally multinomial logistic regression analyses were performed, and showed that AOD 500 at nasal angle, iris thickness at temporal angle, TICL at nasal angle were the strongest predictive parameters of subtypes of primary angle closure.

This result partially coincided with Xu, *et al*., [17] study that evaluated the baseline ocular biometric risk variables for advancement from PACS to PAC or AAC noticed that high-risk characteristics, such as a horizontal AOD500 of less than 0.042 mm, a horizontal IC of less than 0.335 mm, and a greater age of 58 years, impart a larger chance of progression than their low-risk counterparts. Additionally, this outcome was consistent with Wang *et al*.'s [23] investigation, which discovered that rising iris thickness is probably a factor in the emergence of angle closure and, eventually, PACG. The iris was thicker in angle closure eyes than in normal eyes after age, sex, ACD, and pupil size adjustments. However, Guzman *et al*.'s [12] study that illustrated that ACD, TISA750, and LV are significant factors that were related with APAC and may contribute to APAC pathogenesis did not comply with this conclusion.

Limitations: A small sample size. The semi-automated way of interpretation of results with manual location of scleral spur. Additionally, with the Topcon SS AS OCT software, we could not measure areas and volume parameters. Only static anterior segment characteristics were assessed; as a result, dynamic variables like adjustments due to accommodation or modifications in iris volume with pupil dilation or choroidal effusion were excluded.

Conclusions

ASOCT can be used to assess anterior chamber angle. Also, AS-OCT has a role to determine which parameters are the strongest predictive factors of major angle closure variants. AS-OCT could be used as investigative tool for diagnosis and maybe management of glaucoma patients.

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References

1. Dorairaj SK, Tello C, Liebmann JM, Ritch R. Narrow

angles and angle closure: anatomic reasons for earlier closure of the superior portion of the iridocorneal angle. Archives of ophthalmology. 2007 Jun 1;125(6):734-749.

2. Friedman DS, Wolfs RC, O'Colmain BJ, Klein BE, Taylor HR, West S, *et al*. Prevalence of open-angle glaucoma among adults in the United States. Arch Ophthalmol. 2004;122:532-538.
3. Tarongoy P, Ho CL, Walton DS. Angle-closure glaucoma: the role of the lens in the pathogenesis, prevention, and treatment. Survey of ophthalmology. 2009 Mar 1;54(2):211-225.
4. Shabana N, Aquino MC, See J, Ce Z, Tan AM, Nolan WP, *et al*. Quantitative evaluation of anterior chamber parameters using anterior segment optical coherence tomography in primary angle closure mechanisms. Clin Exp Ophthalmol. 2012 Nov;40(8):792-801.
5. Barkana Y, Dorairaj SK, Gerber Y, Liebmann JM, Ritch R. Agreement between gonioscopy and ultrasound biomicroscopy in detecting iridotrabecular apposition. Archives of Ophthalmology. 2007 Oct 1;125(10):1331-1335.
6. Congdon NG, Quigley HA, Hung PT, Wang TH, Ho TC. Screening techniques for angle-closure glaucoma in rural Taiwan. Acta Ophthalmologica Scandinavica. 1996 Apr;74(2):113-119.
7. Lavanya R, Foster PJ, Sakata LM, Friedman DS, Kashiwagi K, Wong TY, Aung HT, Alfred T, Gao H, Ee AG, Seah SK. Screening for narrow angles in the Singapore population: evaluation of new noncontact screening methods. Ophthalmology. 2008 Oct 1;115(10):1720-1727.
8. Izatt JA, Hee MR, Swanson EA, Lin CP, Huang D, Schuman JS, *et al*. Micrometer-scale resolution imaging of the anterior eye *in vivo* with optical coherence tomography. Arch Ophthalmol. 1994;112:1584-1589.
9. Nongpiur ME, He M, Amerasinghe N, Friedman DS, Tay WT, Baskaran M, *et al*. Lens vault, thickness, and position in Chinese subjects with angle closure. Ophthalmology. 2011 Mar 1;118(3):474-479.
10. 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 Oct 1;117(10):1967-1973.
11. Moghimi S, Vahedian Z, Zandvakil N, Mohammdi M, Fakhraie G, Nassiri N, *et al*. Role of lens vault in subtypes of angle closure in Iranian subjects. Eye. 2014 Mar;28(3):337-343.
12. Guzman CP, Gong T, Nongpiur ME, Perera SA, How AC, Lee HK, *et al*. Anterior segment optical coherence tomography parameters in subtypes of primary angle closure. Investigative ophthalmology & visual science. 2013 Aug 1;54(8):5281-6528.
13. van Herick W, Shaffer RN, Schwartz A. Estimation of width of angle of anterior chamber: incidence and significance of the narrow angle. American journal of ophthalmology. 1969 Oct 1;68(4):626-529.
14. Seager FE, Wang J, Arora KS, Quigley HA. The effect of scleral spur identification methods on structural measurements by anterior segment optical coherence tomography. Journal of glaucoma. 2014 Jan 1;23(1):e29-38.
15. Dorairaj S, Oliveira C, Fose AK, Liebmann JM, Tello C, Barocas VH, *et al*. Accommodation-induced changes in iris curvature. Experimental eye research. 2008 Feb 1;86(2):220-225.
16. Nolan WP, See JL, Chew PT, Friedman DS, Smith SD, Radhakrishnan S, *et al*. Detection of primary angle closure using anterior segment optical coherence tomography in Asian eyes. Ophthalmology. 2007 Jan 1;114(1):33-39.
17. Xu BY, Friedman DS, Foster PJ, Jiang Y, Porporato N, Pardeshi AA, *et al*. Ocular biometric risk factors for progression of primary angle closure disease: the Zhongshan angle closure prevention trial. Ophthalmology. 2022 Mar 1;129(3):267-275.
18. Nongpiur ME, Aboobakar IF, Baskaran M, Narayanaswamy A, Sakata LM, Wu R, *et al*. Association of baseline anterior segment parameters with the development of incident gonioscopic angle closure. JAMA ophthalmology. 2017 Mar 1;135(3):252-258.
19. Narayanaswamy A, Sakata LM, He MG, Friedman DS, Chan YH, Lavanya R, *et al*. Diagnostic performance of anterior chamber angle measurements for detecting eyes with narrow angles: an anterior segment OCT study. Archives of ophthalmology. 2010 Oct 11;128(10):1321-1327.
20. Moghimi S, Vahedian Z, Fakhraie G, Ghaffari R, Eslami Y, Jabarvand M, Zarei R, Mohammadi M, Lin S. Ocular biometry in the subtypes of angle closure: an anterior segment optical coherence tomography study. American journal of ophthalmology. 2013 Apr 1;155(4):664-673.
21. Melese EK, Chan JD, Blieden LS, Chuang AZ, Baker LA, Bell NP, *et al*. Determination and validation of thresholds of anterior chamber parameters by dedicated anterior segment optical coherence tomography. American journal of ophthalmology. 2016 Sep 1;169:208-217.
22. Radhakrishnan S, Goldsmith J, Huang D, Westphal V, Dueker DK, Rollins AM, *et al* . Comparison of optical coherence tomography and ultrasound biomicroscopy for detection of narrow anterior chamber angles. Archives of ophthalmology. 2005 Aug 1;123(8):1053-1059.
23. Wang BS, Narayanaswamy A, Amerasinghe N, Zheng C, He M, Chan YH, *et al*. Increased iris thickness and association with primary angle closure glaucoma. British Journal of Ophthalmology. 2011 Jan 1;95(1):46-50.

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