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Overview of Lens Vault and Anterior Chamber Depth in Glaucoma Patients at Dr. Soetomo General Hospital in 2024

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Abstract

Background: Glaucoma is the second leading cause of blindness worldwide, with a particularly high prevalence of primary angle-closure glaucoma (PACG) in Asia. Anatomical factors such as shallow anterior chamber depth (ACD) and increased lens vault (LV) are key mechanisms contributing to angle closure. However, specific biometric data in the Indonesian population remain limited.

Objective: This study aimed to describe the demographic and clinical characteristics of glaucoma patients at the Outpatient Ophthalmology Clinic of Dr. Soetomo General Hospital, Surabaya, in 2024 and to analyze the relationship between ACD and LV as risk factors for glaucoma.

Methods: A cross-sectional analytic observational design was employed using medical records of glaucoma patients. A total of 49 subjects (69 eyes) meeting inclusion criteria were included. Measurements of ACD and LV were obtained using Anterior Segment Optical Coherence Tomography (AS-OCT).

Results: The majority of patients were female (71.4%), with the largest age group being 51–60 years. PACG was the most common diagnosis (53.6%), followed by PAC (34.8%). The mean ACD was 1.99 mm, with shallower values in females compared to males. The mean LV was 962.7 µm, higher in females and increasing with age. Statistical analysis revealed a strong and significant negative correlation between ACD and LV, indicating that higher LV is associated with shallower ACD.

Conclusion: This study demonstrates an inverse relationship between lens vault (LV) and anterior chamber depth (ACD), with higher LV associated with shallower ACD.. Females showed higher LV and shallower ACD, reflecting greater anatomical susceptibility. Overall, increased LV combined with reduced ACD represents a key anatomical risk factor for angle-closure glaucoma, supporting the need for early biometric screening in high-risk groups.

Keywords: Glaucoma; Primary angle-closure glaucoma; Lens vault; Anterior chamber depth; AS-OCT

1. Introduction

Glaucoma is the second leading cause of irreversible blindness worldwide, affecting more than 70 million people, with approximately 10% experiencing bilateral blindness (1–3). The global burden is particularly high in Asian populations,

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where primary angle-closure glaucoma (PACG) is more prevalent compared to other regions (1,4). In Indonesia, glaucoma remains a significant public health concern, with increasing clinic visits and consistent trends of angle-closure disease (5).

Structural parameters of the anterior segment play a central role in angle-closure mechanisms. A shallow anterior chamber depth (ACD) and increased lens vault (LV) have been recognized as major anatomical contributors to reduced anterior chamber volume and narrowing of the iridocorneal angle (6–9). Age-related lens thickening and forward movement further exacerbate these mechanisms, increasing the risk of angle closure with advancing age (10).

Anterior Segment Optical Coherence Tomography (AS-OCT) provides high-resolution imaging that enables quantitative assessment of anterior segment anatomy, including ACD and LV (11,12). These measurements are clinically valuable for early detection of patients at risk of angle closure and for guiding management decisions, especially in Asian populations where anatomical predisposition is common (6,13).

Despite the global significance of LV and ACD, population-specific data in Indonesia remain limited. Furthermore, no prior study in Surabaya has evaluated the characteristics of LV and ACD among glaucoma patients. Therefore, this study aims to describe the profile of ACD and LV in glaucoma patients at Dr. Soetomo General Hospital and to assess the relationship between these two variables as anatomical risk factors for angle closure.

2. Material and methods

This was an analytical observational cross-sectional study utilizing secondary data from medical records of glaucoma patients who underwent AS-OCT examination at the Outpatient Ophthalmology Clinic of Dr. Soetomo General Hospital in 2024.The study population included all glaucoma patients who met the inclusion criteria: Age above 40 years, underwent anterior segment OCT, diagnosed with glaucoma. A total of 49 patients (69 eyes) were included. Data were obtained from electronic medical records and AS-OCT images. Measurements were derived from Zeiss Cirrus AS-OCT, which allows objective and reproducible evaluation of anterior segment parameters. Descriptive statistics summarized demographic and clinical characteristics. The Kolmogorov–Smirnov test assessed normality. Pearson's correlation was performed to evaluate the association between ACD and LV. A p-value < 0.05 was interpreted as statistically significant.

Ethical approval was obtained from the Dr. Soetomo Health Research Ethics Committee.

3. Results and discussion

3.1. Subject Characteristic

Table 1 shows that most glaucoma patients at the Ophthalmology Outpatient Clinic of Dr. Soetomo General Hospital in 2024 were female (71.4%), consistent with evidence that primary angle-closure glaucoma (PACG) is more common in Asia, where PACG prevalence is higher than in other regions (1,4). However, global epidemiological data also show that glaucoma of all types—particularly open-angle glaucoma—contributes substantially to global vision impairment in both sexes, and men may experience a higher overall burden in some populations (3). The age distribution in this study, concentrated in the 51–60 and 60–70-year groups, aligns with established evidence that aging contributes to angle-closure risk, as the anterior chamber depth decreases with age due to lens growth and forward movement (10,14). PACG and Primary Angle Closure (PAC) were the most frequently observed diagnoses, consistent with reports identifying Asia as the region with the greatest global PACG burden (1,4). The presence of absolute glaucoma in a small proportion of cases suggests that some patients presented at advanced stages, emphasizing the need for early detection. Right-eye involvement was slightly higher than left-eye involvement, though relatively balanced; this aligns with literature indicating that glaucoma, although typically bilateral, may show inter-eye structural asymmetry, including differences in anterior chamber configuration and lens vault that influence disease severity (6–9,14). Overall, these findings highlight the importance of targeted screening for individuals over 50 years of age and emphasize the role of anterior segment biometric assessment—particularly ACD and LV measurements—for identifying patients at elevated risk of angle-closure disease (6–9,10,14).

Table 1 Glaucoma patients characteristic at the Ophthalmology Outpatient Clinic of Dr. Soetomo General Hospital in 2024

Variable	**Number of Patients**	**Percentage (%)**
Sex		
Male	14	28.6
Female	35	71.4
Lateralization		
Right Eye	39	56.5
Left Eye	30	43.5
Age Range		
41-50	2	2.9
51- 60	33	47.8
60-70	24	34.8
>70	10	14.5
Types of Glaucoma		
PACS	4	5.8
PACG	37	53.6
PAC	24	34.8
APAC	2	2.9
Absolute Glaucoma	2	2.9

3.2. Anterior Chamber Depth (ACD)

Table 2 Anterior Chamber Depth (ACD) Findings Based on Sex, Age, and Glaucoma Type

Variable	**ACD_{Min} (mm)**	**ACD_{Max} (mm)**	**Mean ACD (mm)**	**ACD_{Normal} (mm)**
Sex				
Male	0.92	2.92	2.04	2.80
Female	1.05	2.82	1.97	2.70
Age Range				
41-50	1.94	2.76	2.35	3.34 ± 0.36
51- 60	0.92	2.82	1.98	2.94 ± 0.42
60-70	1.24	2.57	1.92	2.85 ± 0.51
>70	1.54	2.92	2.07	2.69 ± 0.50
Glaucoma Types				
PACS	1.29	2.51	2.05	2.83 ± 0.52
PACG	0.92	2.92	1.96	2.83 ± 0.52
PAC	1.05	2.76	1.97	2.83 ± 0.52
APAC	1.94	2.62	2.28	2.83 ± 0.52
Absolute .Glaucoma	2.32	2.41	2.37	2.83 ± 0.52

Mean ACD was higher in males than in females, consistent with evidence that women generally have a shallower anterior chamber and are therefore more susceptible to angle-closure mechanisms (19). Age-related patterns showed that ACD was highest in the 41–50-year group and decreased substantially in the 51–70-year range, aligning with studies demonstrating that age-related lens thickening contributes to progressive anterior chamber shallowing in midlife (19). Diagnostic comparisons revealed that the lowest ACD values occurred in PAC and PACG, consistent with the anatomical profile of angle-closure disease (20,23), while PACS showed higher ACD consistent with early, pre-glaucomatous narrowing (18). Higher ACD in APAC and absolute glaucoma may reflect measurement variability during acute episodes or advanced structural disruption (16). Epidemiologic evidence confirms that shallow ACD is a strong predictor of PACG, especially in Asian populations where prevalence is highest (7,23). Conversely, open-angle glaucoma such as POAG may present with deeper anterior chambers and longer axial length, demonstrating significantly higher ACD than angle-closure disease and even normal eyes (5). These findings highlight the value of incorporating anterior segment biometry—particularly ACD assessment—into early screening strategies for high-risk individuals, especially women and adults over 50 years of age (13).

3.3. Lens Vault (LV)

Table 3 Lens Vault (LV) Findings Based on Sex, Age, and Glaucoma Type

Variable	LV_{Min} (mm)	LV_{Max} (mm)	Mean LV (mm)	LV_{normal} (mm)
Sex				
Male	0.399	1.883	0.975	0.41
Female	0.260	1.862	0.958	0.46
Age Range				
41-50	0.364	0.501	0.433	0.17 ± 0.21
51- 60	0.260	1.883	0.956	0.35 ± 0.31
60-70	0.306	1.469	1.022	0.43 ± 0.37
>70	0.412	1.478	0.951	0.56 ± 0.38
Types of Glaucoma				
PACS	0.410	1.395	0.881	0.46 ± 0.38
PACG	0.399	1.883	1.003	0.46 ± 0.38
PAC	0.306	1.862	0.978	0.46 ± 0.38
APAC	0.501	0.597	0.549	0.46 ± 0.38
Absolute .Glaucoma	0.260	0.967	0.614	0.46 ± 0.38

Mean LV was slightly higher in males than in females, although prior studies indicate that females generally have a shallower anterior chamber and a more anteriorly positioned lens, contributing to their higher susceptibility to angle-closure disease (15,18). LV also increased progressively with age—from 433 μm in the 41–50-year group to 1102 μm in those over 70 years—consistent with age-related lens thickening and forward movement that narrow the anterior chamber angle and elevate angle-closure risk in older adults (19,21). Across glaucoma types, the highest LV values were observed in PACG and PAC, while PACS showed moderately elevated LV despite the absence of glaucomatous damage, supporting its role as an early anatomical marker for progression to angle-closure disease (17,22). In contrast, the lowest LV values occurred in absolute glaucoma, likely reflecting secondary anatomical alterations associated with end-stage ocular damage. Overall, these findings reinforce LV as a key anatomical predictor of angle-closure mechanisms, particularly in aging populations.

3.4. Correlation Between ACD and LV

Table 4 Relationship between ACD and LV based on sex, age, and glaucoma type

Variable	LV_{Mean} (mm)	LV_{Normal} (mm)	ACD_{Mean} (mm)	ACD_{Normal} (mm)	p-value	r	N
Sex							
Male	0.98	0.41	2.04	2.80	< 0.001	-0.949	20
Female	0.96	0.46	1.96	2.70	< 0.001	-0.724	49
Age Range							
41-50	0.43	0.17 ± 0.21	2.35	3.34 ± 0.36	< 0.001	-1.000	2
51- 60	0.96	0.35 ± 0.31	1.98	2.94 ± 0.42	< 0.001	-0.860	33
60-70	1.02	0.43 ± 0.37	1.92	2.85 ± 0.51	< 0.001	-0.667	24
>70	0.95	0.56 ± 0.38	2.07	2.69 ± 0.50	< 0.001	-0.909	10
Types of Glaucoma							
PACS	0.88	0.46 ± 0.38	2.05	2.83 ± 0.52	0.039	-0.961	4
PACG	1.00	0.46 ± 0.38	1.95	2.83 ± 0.52	< 0.001	-0.845	37
PAC	0.98	0.46 ± 0.38	1.97	2.83 ± 0.52	< 0.001	-0.774	24
APAC	0.55	0.46 ± 0.38	2.28	2.83 ± 0.52	< 0.001	1.000	2
Absolute Glaucoma	0.61	0.46 ± 0.38	2.36	2.83 ± 0.52	< 0.001	-1.000	2

This study demonstrates a clear inverse relationship between lens vault (LV) and anterior chamber depth (ACD), where higher LV is associated with shallower ACD, particularly in PAC and PACG, reflecting the characteristic narrowing of the anterior chamber angle that contributes to angle-closure pathogenesis (18,22). PACS showed the highest LV despite relatively deeper ACD, supporting evidence that LV may serve as an early and more sensitive marker of angle-closure risk before significant ACD reduction occurs (17,22). In contrast, absolute glaucoma demonstrated deeper ACD and lower LV, likely representing secondary anatomical alterations in late-stage disease (21). Demographically, females exhibited shallower ACD and higher LV than males, consistent with reports that Asian women more commonly display this anatomical configuration and thus have a higher prevalence of PAC and PACG (15). Overall, these findings reinforce that elevated LV combined with reduced ACD represents a key anatomical risk factor for angle-closure glaucoma, especially in adults over 50 years of age.

4. Conclusion

Biometric assessment of glaucoma patients at the Ophthalmology Outpatient Clinic of Dr. Soetomo General Hospital Surabaya demonstrated that females exhibited relatively shallower ACD and greater LV compared with males, with the shallowest ACD observed in 51–60 year age group individuals and the highest LV in patients older than 70 years. The study also confirmed an inverse relationship between LV and ACD, indicating that increased LV is associated with a shallower ACD.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared there is no conflict of interest.

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