Original Research Article

A Clinical Study of Anterior Chamber Depth Measurement as a Screening Tool for Primary Angle Closure Glaucoma

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Abstract

Background: Glaucoma is the world's second largest cause of blindness, with permanent visual loss. Angle-closure glaucoma is regarded as the primary cause of permanent blindness globally, with a greater incidence among Asians.[1] PACG is characterized by narrow or closed anterior chamber angle, which leads to increased intraocular pressure and optic nerve damage Anatomical risk factors include shallow anterior chamber depth, small axial length and lens thickness.

Need for Screening: Gonioscopy is the gold standard for angle evaluation, but it is technique – sensitive and not always practical for mass screening. ACD measurement is simple non-invasive screening alternative.

Objectives:
1. To evaluate anterior chamber depth measurement as a method of screening for PACG.
2. To compare the parameters in eyes with PACS, PAC, and PACG.

Materials and Methods: This is a prospective study conducted on 150 patients with shallow anterior chamber and patients presenting with signs and symptoms of angle closure. Detailed history was collected. Detailed ophthalmic examination was done for classification into groups.

Results: Out of 150 patients, 36 eyes of open angles, 46 eyes of PACS, 33 eyes of PAC and 35 eyes with PACG were identified. Our findings demonstrated that ACD is a significant for identifying individuals at risk for primary angle closure glaucoma.

This study revealed that there is statistically significant difference between the mean ACD of PACS, PAC, and PACG.

Conclusion: This study concluded that anterior chamber depth measurement as a screening tool for primary angle closure glaucoma is effective especially in primary outreach centres where sophisticated equipment may not be available.

Keywords: Anterior Chamber Depth, Primary Angle Closure Suspect, Primary Angle Closure, Primary Angle Closure Glaucoma, Axial Length, Lens Thickness.

Introduction

Glaucoma is a chronic, progressive optic neuropathy caused by a variety of eye illnesses that damage the optic nerve, resulting in loss of vision. The major risk factor is increased intraocular pressure. It is the world's second largest cause of blindness, with permanent visual loss. Among the divisions of glaucoma Angle-closure glaucoma is regarded as the primary cause of permanent blindness globally, with a greater incidence among Asians. [1]

Angle-closure glaucoma impacted roughly 15 million persons globally in 2010, with a anticipated increase to 21 million by 2020. Tham et al.

predicted that the global prevalence of PACG will increase to 23.36 million in 2020 and 32.04 million in 2040. Similarly, Asians are expected to have 17.96 million and 24.5 million, respectively. [2] In India, primary angle-closure glaucoma accounts for nearly half of all primary glaucoma cases. This condition's long-term morbidity can be avoided with early detection and treatment. The high blindness incidence in India is mostly owing to a huge number of undiagnosed glaucoma patients in the community, emphasizing the significance of early identification. [2,4]

A shallow anterior chamber, thick lens, and a shorter axial length of the globe are all risk factors for primary angle-closure glaucoma. As people age, changes in ocular dimensions, such as increased lens thickness, cause a shallower anterior chamber, resulting in narrower angles. [4,7]

Ocular biometry is the measurement of numerous eye parameters, such as axial length, anterior chamber depth, and lens thickness. [7]

Peripheral ACD is substantially related with main angle closure. ACD has been shown to identify 81-90% of angle closures in a variety of circumstances. Its sensitivity varies from 76 to 83%, while its specificity ranges from 67.2 to 88.9%. [4-6] The method of assessing axial anterior chamber depth using the slit lamp is a low-cost, quick, quantitative, and non-contact screening tool that may be used in regular clinical exams. We encourage its usage, particularly in basic outreach-sites where advanced equipment is not accessible. [7]

Early identification and treatment can help avoid significant vision loss. Ocular biometry involves measuring eye parameters such as axial length, lens thickness, and anterior chamber depth. A-scan ultrasonography is a portable, non-invasive technology for readily measuring ocular measurements. The goal of the study is to compare the differences between 1) Primary angle closure suspect, 2) Primary angle closure, and 3) Primary angle closure glaucoma. [4-7]

Primary angle closure suspect: A gonioscopy showing at least 270° of iridotrabecular contact together with normal intraocular pressure, optic disc, and visual fields

Primary angle closure: The presence of normal optic disc and visual fields, elevated IOP or PAS, and iridotrabecular contact of at least 270° on gonioscopy. Iris whorling, loss of pupillary ruff, endothelial cell destruction, and glaukom flecken are other signs of PAC.

Primary angle closure glaucoma: The existence of elevated IOP, iridotrabecular contact more than 270°, optic nerve damage, and abnormalities in the visual field.

Materials and Methods

- The study is performed on patients attending the ophthalmology outpatient department at the regional Eye Hospital, Kurnool.
- The relevant details with history and clinical examination of patients are recorded in a specifically designed proforma after prior consent from the patient.

Detailed ophthalmic examination is done, consisting of:

1. Visual acuity assessment using Snellen's chart.
2. Anterior segment examination- including slit lamp biomicroscopic examination.
3. Fundus examination with both direct and indirect ophthalmoscopy.
4. IOP with Schiotz tonometer
5. Goldmann applanation tonometer
6. A-scan Biometry
7. B- scan Ultrasound
8. Gonioscopy
9. Pachymetry

Study design: Prospective study.

Duration of the study: 2 years.

Place of study: Regional Eye Hospital, Kurnool Medical College, Kurnool, Andhra Pradesh, India.

Sample size: 150 patients,

Source of Data: The main source of data for study will be patients attending regional eye hospital / Government General Hospital, Kurnool Medical College, Kurnool from July 2022 to June 2024.

Inclusion Criteria:

1. Patients with shallow anterior chamber depth.
2. Patients with symptoms and signs of angle closure glaucoma.
3. Patient who have given consent for study and examination.

Exclusion Criteria:

1. Open angle glaucoma.
2. H/o ocular trauma.
3. Anterior segment pathology.
4. Posterior segment pathology.
5. Secondary angle closure glaucoma.

Statistical Analysis: A Microsoft Excel datasheet was used to record the data, and SPSS version 22 was used for analysis. Frequencies and proportions were used to illustrate categorical data. For qualitative data, a chi-square test was employed as a significance test. The standard deviation and mean were used to describe continuous data. The mean difference between two or more quantitative variables was found using the ANOVA test, which was also utilized as a measure of significance for qualitative variables.

P-value of <0.05 was considered statistically significant after applying all statistical tests' requirements.
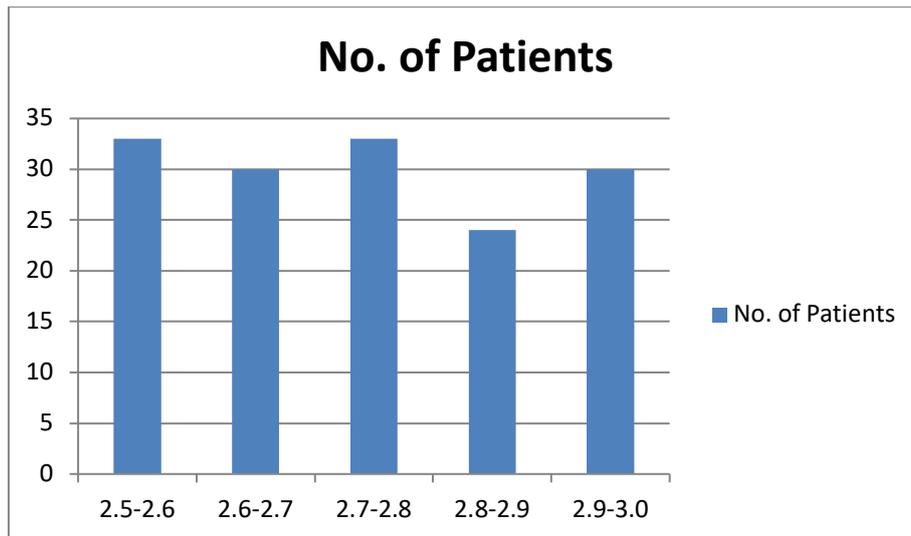
Figure 1: Distribution of Anterior Chamber Depth (mm) by Smith's Method

The figure above shows the distribution of anterior chamber depth (ACD) for patients in the study, categorized into five ranges: 2.5-2.6 mm, 2.6-2.7 mm, 2.7-2.8 mm, 2.8-2.9 mm, and 2.9-3.0 mm. The highest percentage of patients falls into the 2.5-2.6 mm and 2.7-2.8 mm ranges each with a total of 33 patients (22.00%). This is followed by the 2.6-2.7 mm and 2.9-3.0 mm ranges, each with 30 patients (20.00%). The 2.8-2.9 mm range includes 24 patients (16.00%).

Table 1: Anterior Chamber Depth (mm) Distribution by Van Herick's Method

Grade	No of Patients	Percentage
GRADE 1	79	52.67%
GRADE 2	71	47.33%
Grand Total	150	100.00%

This table presents the distribution of anterior chamber depth (ACD) as measured by Van Herick's method, categorized by grades. The grades are divided into GRADE 1 and GRADE 2.GRADE 1 includes 79 patients, accounting for 52.67% of the total, while GRADE 2 includes 71 patients, representing 47.33% of the total. This distribution shows that a higher percentage of patients fall under GRADE 1 compared to GRADE 2. The data is crucial for understanding the prevalence of different anterior chamber depth grades among the patients and assessing the effectiveness of Van Herick's method as a screening tool for primary angle closure glaucoma.
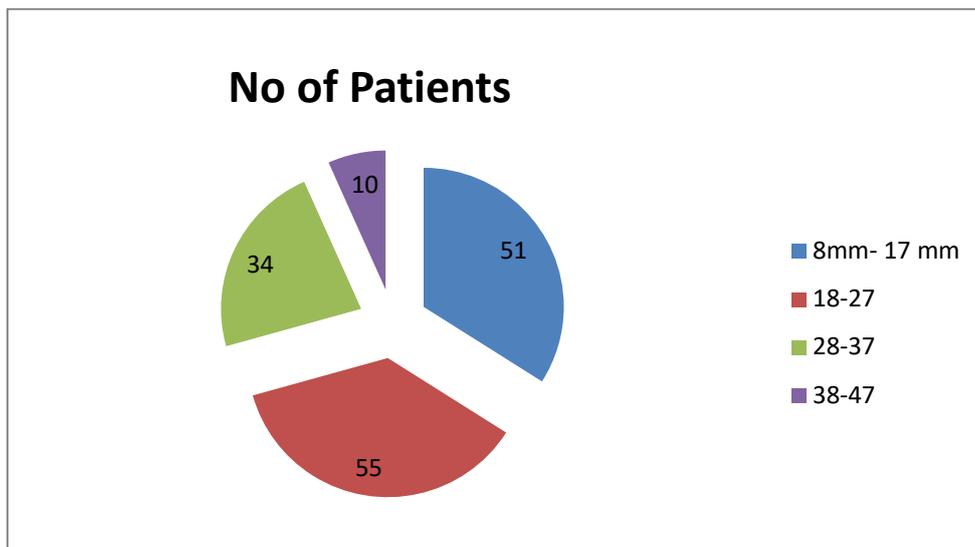

Figure 2: IOP (mm Hg) Distribution by Goldmann Applanation Tonometer

The Figure above presents the distribution of intraocular pressure (IOP) measurements in millimeters of mercury (mm Hg) using the Goldmann applanation tonometer. The IOP values are grouped into four ranges (8-17 mm Hg, 18-27 mm Hg, 28-37 mm Hg, and 38-47 mm Hg) with the corresponding number of patients and their percentages. 51 patients (34.00%) has IOP Range 8-17 mm Hg, 55 patients (36.67%) has IOP Range 18-27 mm Hg, 34 patients (22.67%) has IOP Range 28-37 mm Hg and 10 patients (6.67%) had IOP Range 38-47 mm Hg:

Table 2: Distribution of Patients Based on Gonioscopy Findings

Gender	Closed	Narrow	Open	Total	Percentage
Female	26	24	22	72	48.00%
Male	39	25	14	78	52.00%
Total	65	49	36	150	100.00%

The distribution of patients based on anterior chamber angle status and gender provides valuable insights into the differences in the prevalence of closed, narrow, and open angles among the study population.

- **Closed Angles**: Among patients with closed angles, 26 (40.00%) were female and 39 (60.00%) were male, making up a total of 65 (43.33%) patients.

- **Narrow Angles**: Among patients with narrow angles, 24 (48.98%) were female and 25 (51.02%) were male, making up a total of 49 (32.67%) patients.

- **Open Angles**: Among patients with open angles, 22 (61.11%) were female and 14 (38.89%) were male, making up a total of 36 (24.00%) patients.
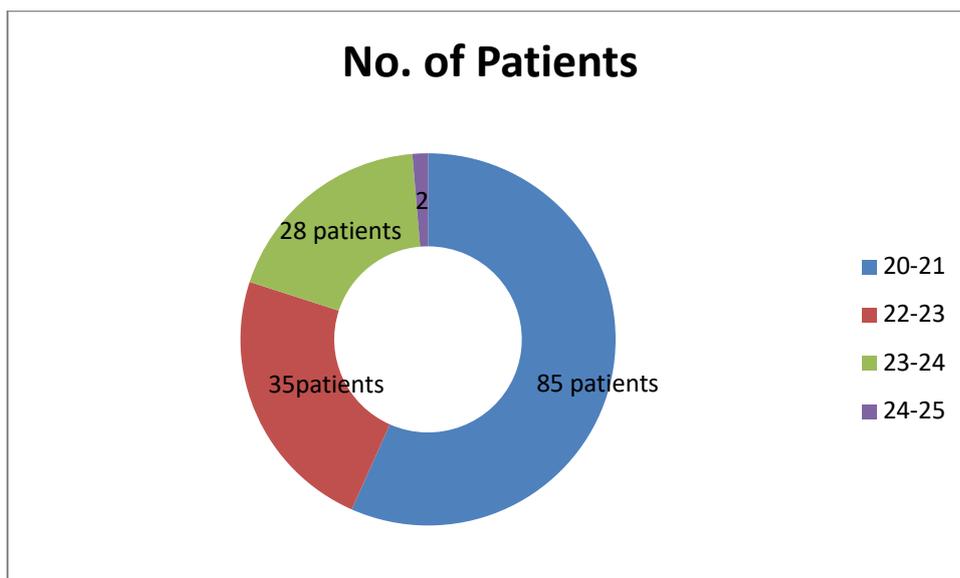

FIGURE 3: Axial Length Distribution

The Figure above shows the distribution of A-scan measurements for patients in the study.

The measurements are categorized into four ranges: 20-21 mm, 22-23 mm, 23-24 mm, and 24-25 mm. The highest percentage of patient's falls into the 20-21 mm range with a total of 85 patients (56.67%).This is followed by the 22-23 mm range with 35 patients (23.33%). The 23-24 mm range includes 28 patients (18.67%).

The lowest number of patients is observed in the 24-25 mm range with 2 patients (1.33%). This distribution is crucial for understanding the variation in A-scan measurements among the patients.

Table 3: Distribution of Diagnosis

Diagnosis	No. of Patients	Percentage (%)	Mean	std	P Value
PAC	33	28.45%	2.93	0.16	<0.05
PACG	36	31.03%	2.76	0.21	
PACS	47	40.52%	2.86	0.17	
Grand Total	116	100.00%			

In the current study, the distribution of diagnoses among patients was categorized into three groups: PAC (Primary Angle Closure), PACG (Primary Angle Closure Glaucoma), and PACS (Primary Angle Closure Suspect). Out of the total 116 patients, 33 (28.45%) were diagnosed with PAC, 36 (31.03%) with PACG, and 47 (40.52%) with PACS. These findings highlight the distribution of angle closure conditions within the study population, showing a higher prevalence of PACS compared to PAC and PACG. The mean ACD for PAC was 2.93±0.16 mm, for PACG it is 2.76±0.21 mm and for PACS group it is 2.86±0.17 mm. The test results showed a p-value of less than 0.05, indicating that there is a statistically significant difference in the mean ACDs between the groups.

Table 4: Comparison between Groups for Mean Axial Length

Group	Mean Axial Length Mean± Std	P Value	Lens thickness Mean± Std	P Value
PAC	21.52±1.25	0.42	4.416±0.19	0.08
PACG	21.26±1.12		4.417±0.22	
PACS	21.60±1.23		4.410±0.27	

The table above presents the comparison of mean axial lengths among different groups of patients: PAC, PACG, and PACS. The mean axial length for PAC was 21.52± 1.25 mm. For PACG, the mean axial length was 21.26± 1.12 mm. The PACS group had a mean axial length of 21.60±1.23 mm. The test results showed a p-value of 0.42, indicating that there is no statistically significant difference in the mean axial lengths between the groups.

Similarly the comparison of mean lens thickness for PAC was 4.416±0.19 mm, for PACG it is 4.417±0.22 mm and for PACS group had a mean LT of 4.41± 0.27 mm. The ANOVA test results showed a p-value of 0.08, indicating that there is no statistically significant difference in the mean LT between the groups

Discussion

Nangia et al. (2013): Conducted a population-based study in rural central India and reported that 88 patients (58.67%) were categorized as GRADE 1, and 62 patients (41.33%) as GRADE 2. This close alignment with the current study reinforces the consistency and reliability of the results. [8]

Thomas et al. (2003): In a study conducted in southern India, found that 84 patients (56.00%) were categorized as GRADE 1, and 66 patients (44.00%) as GRADE 2. These findings are very similar to the current study's results, further validating the distribution patterns observed. [9]

These comparisons highlight the consistency in ACD grading across different studies, emphasizing the reliability of Van Herick's method in assessing anterior chamber depth.

The distribution of axial length (Axl) measurements in the current study provides valuable insights into ocular biometric parameters among patients. The A-scan measurements were categorized into four ranges: 20-21 mm, 22-23 mm, 23-24 mm, and 24-25 mm. In the current study, 85 patients (56.67%) had A-scan measurements in the 20-21 mm range, 35 patients (23.33%) in the 22-23 mm range, 28 patients (18.67%) in the 23-24 mm range, and 2 patients (1.33%) in the 24-25 mm range. [10,11]

Rao et al. (2019): This study found that a significant portion of their population had A-scan measurements within the 20-21 mm range (30.00%) and 22-23 mm range (26.67%). These findings closely align with the current study's results, which show 20-21 mm range (56.67%) and 22-23 mm range (23.33%).

Gupta et al. (2020): Conducted in a hospital-based setting, this study reported similar trends, with the majority of their patients having A-scan measurements in the 20-21 mm range (33.33%) and 22-23 mm range (25.33%). The distribution in the current study mirrors these results, indicating a consistent pattern in A-scan measurements across different Indian populations.

In the current study, the mean axial length (AL) was compared across PAC, PACG, and PACS groups and juxtaposed with findings from George et al. (2018) [10] and Ramakrishna et al. (2016). [11] For PAC, the current study reported a mean AL of 21.52 mm, which is lower than the 22.76 mm reported by George et al. and the 23.26 mm by Ramakrishna et al. In the PACG group, the current study found a mean AL of 21.26 mm, compared to 22.15 mm by George et al. and 22.34 mm by Ramakrishna et al. Similarly, for PACS, the mean AL in the current study was 21.60 mm, while George et al. and Ramakrishna et al. both reported a mean AL of 22.17 mm.

In the current study, the mean anterior chamber depth (ACD) was compared across PAC, PACG, and PACS groups and juxtaposed with findings from George et al. (2018) and Ramakrishna et al. (2016). For PAC, the current study reported a mean ACD of 2.93 mm, which is lower than the 3.22 mm reported by George et al. and the 3.17 mm by Ramakrishna et al. In the PACG group, the current study found a mean ACD of 2.76 mm, compared to 3.30 mm by George et al. and 3.34 mm by Ramakrishna et al. Similarly, for PACS, the mean ACD in the current study was 2.86 mm, while

George et al. and Ramakrishna et al. reported mean ACDs of 3.36 mm and 3.40 mm, respectively. The comparison of mean lens thickness (LT) among different groups of patients PAC, PACG, and PACS provides valuable insights into the anatomical characteristics associated with primary angle closure and its subtypes. In the current study, the mean LT for PAC was 4.416 mm with a standard deviation of 0.19 mm. For PACG, the mean LT was 4.417 mm with a standard deviation of 0.22 mm, and for PACS, the mean LT was 4.410 mm with a standard deviation of 0.27 mm.

Comparing these findings with existing literature, George et al. (2018) reported mean LT values of 4.42 mm for PAC, 4.45 mm for PACG, and 4.40 mm for PACS. Similarly, Ramakrishna et al. (2016) found mean LT values of 4.38 mm for PAC, 4.41 mm for PACG, and 4.39 mm for PACS.

The mean LT values in the current study are very close to those reported by George et al. (2018) and Ramakrishna et al. (2016), with slight variations that could be attributed to differences in measurement techniques, study populations, or geographic factors. Despite these minor differences, the overall trends are consistent, indicating that lens thickness is a crucial parameter in evaluating and managing primary angle closure and its subtypes

Conclusion

The present study aimed to assess anterior chamber depth measurement as a screening tool for primary angle closure glaucoma. This study was conducted at the regional eye hospital, Kurnool Medical College, Kurnool, from July 2022 to June 2024. In the present study 150 eyes were examined. Patients with shallow anterior chamber depth and patients presenting with signs and symptoms of angle closure were examined using slit lamp biomicroscopyand and subjected to various investigations like anterior chamber depth measurement, intra ocular pressure measurement, Gonioscopy, A- scan biometry.

Our findings demonstrated that ACD is a significant parameter for identifying individuals at risk for PACG. In the total of 150 eyes 36 eyes of open angles, 46 eyes of PACS, 33 eyes of PAC and 35eyes with PACG. Among these patients PACS, PAC, PACG are subjected to ocular biometric parameters like ACD, AXL, LT are compared, the study identified a significant prevalence of PACG in older adults and males, consistent with existing literature. Smith's and Van Herick's methods for ACD measurement were effective in identifying at-risk individuals. The p-value for ACD among different diagnostic categories (PAC, PACG, PACS) was less than 0.05, indicating a statistically significant difference. Axial length (AXL) and lens

thickness (LT) showed no statistically significant differences between males and females, with p-values indicating consistency across genders.

The results advocate for the inclusion of ACD measurement in routine ophthalmic examinations, particularly in primary outreach centers where sophisticated equipment may not be available. This approach can significantly enhance the early identification and management of PACG, ultimately reducing the burden of blindness caused by this condition.

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