ASSESSMENT OF LENS THICKNESS IN ANGLE CLOSURE DISEASE

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ABSTRACT

BACKGROUND
Anterior chamber depth and lens thickness have been considered as important biometric determinants in primary angle-closure glaucoma. Patients with primary narrow angle may be classified as a primary angle closure suspect (PACS), or as having primary angle closure (PAC) or primary angle closure glaucoma (PACG). 23.9% of patients with primary angle closure disease are in India, which highlights the importance of understanding the disease, its natural history, and its underlying pathophysiology, so that we may try to establish effective methods of treatment and preventative measures to delay, or even arrest, disease progression, thereby reducing visual morbidity.

AIM
To determine the lens thickness using A-scan biometry and its significance in various stages of angle closure disease.

MATERIALS AND METHODS
Patients attending outpatient department at Minto Ophthalmic Hospital between October 2013 to May 2015 were screened for angle closure disease and subsequently evaluated at glaucoma department.

In our study, lens thickness showed a direct correlation with shallowing of the anterior chamber by determining the LT/ ACD ratio. A decrease in anterior chamber depth is proportional to the narrowing of the angle which contributes to the progression of the angle closure disease from just apposition to occlusion enhancing the risk for optic nerve damage and visual field loss. Hence, if the lens thickness values are assessed earlier in the disease process, appropriate intervention can be planned.

CONCLUSION
Determination of lens changes along with anterior chamber depth and axial length morphometrically can aid in early detection of angle closure. The role of lens extraction for PACG is a subject of increased interest. Lens extraction promotes the benefits of anatomical opening of the angle, IOP reduction and improved vision. This potential intervention may be one among the armamentarium of approaches for PACG. Among the current treatment modalities like laser peripheral iridotomy and medical therapy, lens extraction with trabeculectomy/goniosynechialysis may be beneficial.

KEYWORDS
Primary Angle Closure Suspects (PACS), Primary Angle Closure (PAC), Primary Angle Closure Glaucoma (PACG), Lens Thickness (LT), Anterior Chamber Depth (ACD).

INTRODUCTION: The Hippocratic aphorisms include two mentions of blindness, one of which may refer to glaucoma: 'When headache develops in cases of ophthalmia and accompanies it for a long time, there is a risk of blindness.' The association between shallow anterior chambers and acute attacks of angle-closure glaucoma became clear in the late nineteenth century. Today, we understand that in the angle-closure glaucomas there is increased resistance to outflow because of damage to, or obstruction of, the trabecular meshwork by the peripheral iris, preventing the aqueous humour from reaching the outflow channels.

Glaucoma is ranked as the leading cause of irreversible blindness worldwide by the World Health Organization. It was estimated that by 2010, 3.9 million people with glaucoma would be blind due to primary angle closure glaucoma (PACG). By 2020, this number is projected to increase to 5.3 million.[1] Eighty-six percent of people with PACG are in Asia, with approximately 48.0% in China, 23.9% in India and 14.1% in southeast Asia.[2] These staggering statistics highlight the necessity to elucidate risk factors relevant to angle closure, determining clinical markers for progression of disease, distinguishing differential responses and complications of interventions, and discovering clues as to underlying pathogenic mechanisms. Management of patients with PAC depends on the type of clinical presentation, making the diagnosis of PACS, PAC or PACG, as well as correctly identifying the underlying pathophysiology. And for the individual patient, this scheme of the natural history of primary angle closure addresses both the prognosis for progression, and the stage-appropriate need for treatment.

Removal of the lens, especially if there is any evidence of cataract, is helpful particularly where either the lens thickness or its anterior position is thought to be the main mechanism underlying angle closure. However, if done in the acute scenario, care must be taken during surgery as these eyes are usually associated with high IOPs, shallow anterior chambers, cloudy cornea, decreased corneal endothelial cell counts, floppy iris due to previous ischaemia, posterior synechiae, bulky lens, lax lens zonules, and a high risk of malignant glaucoma.[2]

The increase in lens thickness is associated with shallowing of the anterior chamber. Quantification or morphometric assessment can be done by A-scan ultrasonography and various parameters like axial length, lens thickness and anterior chamber depth can be recorded. Hence, if the lens thickness values are assessed earlier in the disease process, appropriate intervention can be planned. Thus, the aim of our study is to determine the lens thickness using A-scan biometry and its significance in various stages of angle closure disease.

Study Duration: October 2013- May 2015.

Study Design: It is a cross-sectional, non-interventional, non-randomised study. One way analysis of variance was used to compare the different parameters measured.

Sample Size: 112 eyes of 59 patients attending Glaucoma Department of Minto Eye Hospital, Bangalore.

Inclusion Criteria:
1. Primary angle closure suspects (PACS).
2. Primary angle closure (PAC).
3. Primary angle closure glaucoma (PACG).

Exclusion Criteria:
1. Acute angle closure glaucoma.
2. Secondary angle closure glaucoma.
3. Lens related, inflammatory or neovascular glaucoma.

METHODS: Hospital based, cross-sectional study of 112 eyes of 59 patients with PACS, PAC and PACG in whom A-scan biometry was done, were included in the study. The following procedure of tests were conducted on the selected patients.
1. Anterior segment evaluation included visual acuity, slit-lamp examination, Van-Herrick grading of peripheral anterior chamber depth (PACD).
2. Tonometry- IOP recorded using Goldmann applanation tonometry.
3. Gonioscopy was performed using Goldmann 2 mirror lens and Posner 4-mirror goniolens was used for manipulative gonioscopy (indentation). Shaffer grading system of angle evaluation was followed.
4. Optic nerve head evaluation (stereoscopic) was done using +90 D and +78 D lens.
5. A-scan biometry was performed in all cases. Contact method is the most common technique of ocular

biometry. The ultrasound probe is in direct contact with cornea. 5 high amplitude spikes appear on the display.
A. Initial probe corneal spike.
B. Anterior lens spike.
C. Posterior lens spike.
D. Retinal spike.
E. Scleral spike.

The lens thickness was determined. Axial length and anterior chamber depth were also recorded in all cases. The LT/ ACD, Lens axial length factor (LAF), relative lens position were calculated. One way analysis of variance was used to compare the different parameters measured.

RESULTS: The study included 59 patients, of whom 22 were males and 37 were females. Majority of the patients belonged to the age group > 40 years.

Age group (years)	Males	Females
30-40	02	06
41-50	03	14
51-60	09	05
61-70	06	12
>70	02	0
Table 1		
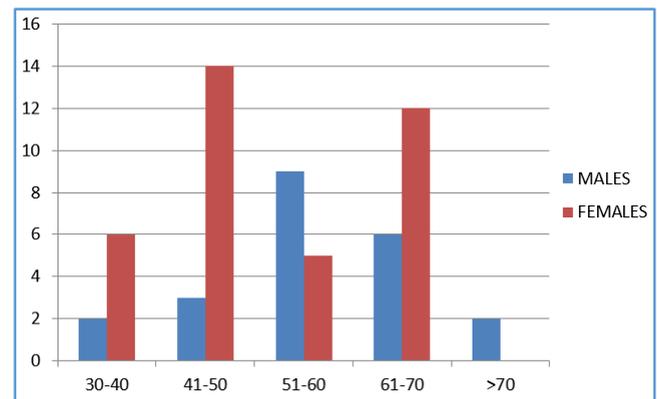
Graph 1

Using the A-scan ultrasonography, anterior chamber depth, lens thickness, and axial length measurements were done. The LT/ACD ratio was calculated. Also, Axial length factor (LAF) = lens thickness/ axial length *10 (relative size of lens), was calculated.

1. Anterior Chamber Depth:

	PACS	PAC	PACG
Mean	2.623 mm	2.367 mm	2.745 mm
Standard deviation	0.4498	0.4998	0.5137
Standard error	0.6859	0.1336	0.06927
Table 2			

By one way analysis of variance, the p-value was found to be 0.0350 which was statistically significant. The mean anterior chamber depth among the 3 subgroups with statistically significant shallow anterior chamber was in PAC group (p- value of 0.035). Hence, mean anterior chamber depth is a significant biometric recording, similar to the results obtained by Sandeep Saxena et al.[1]

2. Lens thickness/anterior chamber depth (LT/ ACD):

	PACS	PAC	PACG
Minimum	0.734	1.342	0.934
Maximum	2.963	3.013	2.692
Average	1.79	2.12	1.61
SD	0.49	0.52	0.43
Table 3			

By one way analysis of variance, significant difference was found with highest LT/ACD in PAC group being 2.12 (p value= 0.0008).

The increase in lens thickness is attributable to shallowing of the anterior chamber. A decrease in anterior chamber depth is proportional to the narrowing of the angle which contributes to the progression of the angle closure disease from just apposition to occlusion. In our study, lens thickness showed a direct correlation with shallowing of the anterior chamber by determining the LT/ACD ratio.

3. Axial length factor (LAF)= lens thickness/ axial length *10:

	PACS	PAC	PACG
Minimum	0.112	0.169	0.117
Maximum	0.265	0.274	0.306
Average	0.20	0.22	0.19
LAF	2.00	2.2	1.9
SD	±0.03	±0.02	±0.04
Table 4			

By one way analysis of variance, significant difference was found between the group with the highest LAF in PAC (p value=0.025).

Also, a study done by Sherpa et al, showed that an axial length of less than 23 mm are at a risk to develop angle closure glaucoma,[3] which correlates with our study. Larger LAFs were predictive of angle closure,[3] which correlated with our study.

DISCUSSION: Glaucoma is the second leading cause of blindness (14%). It has been estimated that 5.3 million people with glaucoma will be blind due to primary angle closure glaucoma (PACG) by 2020.[2] Angle closure can be associated with good visual prognosis, provided it is detected early and the appropriate treatment given. PACG is more common in Asia than in western countries.[4] Patients with PACG are 2.5 times at higher risk of blindness than those with primary open angle glaucoma (POAG). Early

detection is by screening for angle closure disease by detailed anterior segment evaluation. Gonioscopy is the gold standard for identifying individuals at risk for PACG.

In 2002, Foster et al proposed a new and stricter definition of PACG, which placed emphasis on structural and functional change, regardless of intraocular pressure.[5] According to that classification system, if a patient has an eye with an occludable angle and a visual field defect compatible with glaucomatous optic neuropathy, he or she is diagnosed as having PACG. However, eyes with occludable angle and evidence of trabecular meshwork obstruction by the peripheral iris, but no damage to the visual field and optic nerve, are classified as having primary angle closure (PAC). Based on this definition, PAC is less severe than PACG and could be a possible precursor to PACG.

Therefore, in this study, using Foster's diagnostic criteria, we recorded general patient characteristics and used A-scan ultrasonography to characterise ocular biometry in normal, PAC, and PACG eye groups to identify what factors might increase the risk of PACG in PAC patients. The results of such a study might make possible the early detection of PACG and help delay the possible progression of the disease.

The crystalline lens has a pivotal role in primary angle closure (PAC), both in the pathogenesis of pupil block and by exacerbating the effect of non-pupil block mechanisms such as peripheral iris crowding. Eyes with angle closure tend to have shallow anterior chambers and thick, anteriorly positioned lenses when compared with normal eyes.[6]

In our study, quantification or morphometric assessment was done using A-scan ultrasonography and various parameters like axial length, lens thickness and anterior chamber depth were recorded.[1,7] A-scan ultrasonography is non-invasive and portable.

The mean anterior chamber depth among the 3 subgroups with statistically significant shallow anterior chamber was in PAC group (p- value of 0.035). Hence, mean anterior chamber depth is a significant biometric recording. The increase in lens thickness is attributable to shallowing of the anterior chamber. In our study, the highest LT/ ACD was obtained in PAC group being 2.12 (p value= 0.0008). A decrease in anterior chamber depth is proportional to the narrowing of the angle which contributes to the progression of the angle closure disease from just apposition to occlusion enhancing the risk for optic nerve damage and visual field loss. Hence, if the lens thickness values are assessed earlier in the disease process, appropriate intervention can be planned.[2,8] Thus, lens thickness showed a direct correlation with shallowing of the anterior chamber by determining the LT/ ACD ratio.[4,5,7,9]

Cataract surgery has been found to be a more effective treatment for an attack of acute primary angle closure (APAC) than laser iridotomy.[10] In addition to lens thickness, a shallower anterior chamber owing to a change in relative lens position may have a role in the progression from PAC to PACG.[5] The analysis of our study correlates with studies done elsewhere.[11,12]

A limitation of our study may be that we used A-scan ultrasonography to obtain ocular biometry. Therefore, our ACD value represented the distance from corneal epithelium to anterior lens capsule. Strictly speaking, the 'True' ACD, which is the distance from the corneal endothelium to anterior lens capsule, should be calculated by subtracting the CCT from the ACD. However, we did not routinely measure CCT with pachymetry, meaning that we could not obtain a true ACD for our analysis. It was possible that our comparison results of ACD of the controls, PAC, and PACG groups may have been affected by variation in CCT. However, the Liwan eye study conducted in southern China showed CCT did not differ significantly in persons with PACG (546±29 µm) and normal persons (540±31 µm).

CONCLUSION: One of the most important and cost-effective methods of managing PACG in the population currently is by increasing public awareness of the disease so that patients at risk, such as those with a positive family history or with ocular risk factors, can undergo risk assessment and prophylactic treatment where necessary.

Lens extraction for primary angle-closure glaucoma (PACG) is a subject of increased interest recently, with advocates promoting its benefits of anatomical opening of the angle, intraocular pressure (IOP) reduction and improved vision. By morphometric assessment of the lens thickness, anterior chamber depth and axial length, the detection of angle closure in patients and thereby comprehensively managing the case can be done. The role of lens extraction for PACG is a subject of increased interest. Lens extraction promotes the benefits of anatomical opening of the angle, IOP reduction and improved vision. This potential intervention may be one among the armamentarium of approaches for PACG. Among the current treatment modalities like laser peripheral iridotomy and medical therapy, lens extraction with trabeculectomy/goniosynechialysis may be beneficial. Thus, better imaging devices for screening of patients will go a long way to help identify others at risk and thus help to reduce visual morbidity due to this disease.

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