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ORIGINAL ARTICLE

Effect of baseline parameters in patients with primary angle-closure disease undergoing peripheral iridotomy: An anterior segment optical coherence tomography-based study

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Abstract

Purpose: To study the effect of baseline parameters on ASOCT in PACD and evaluate their effect on the success of peripheral iridotomy.
Materials and methods: It is a prospective interventional study that included 151 eyes of 80 patients, ≥ 30 years or older who were diagnosed with PAC, PACS and PACG and underwent laser PI from April 2019 to December 2020. All subjects underwent Snellen visual acuity check, Goldmann applanation tonometry, slit-lamp examination and gonioscopy. AS-OCT was performed before Nd:yag PI and 4 weeks after PI.
Results: 151 eyes of PACD and 151 eyes of age and sex matched control subjects were analysed in this study. 70 eyes of PACS, 49 eyes of PAC and 32 of PACG were included. 70.20% cases were females and the mean age of patient was 51.13 ± 8.33 (mean ± SD) years. PACS eyes responded better to PI (open angles in 62.8%) as compared to PAC (open angles in 44.89%) and PACG (open angles in 15.6 %). Univariate analysis show that a shallower ACD, lesser baseline AOD 500, AOD 750, TISA 500, TISA750, IT500, LV, scleral spur angle and greater ACA at baseline, all predicted greater angle opening after LPI ($P < 0.05$ for all). Multivariable regression analysis demonstrated that greater LPI-induced angle opening was significantly associated with, lower baseline AOD 500 and lower ACD.
Conclusion: ASOCT is good adjunct to gonioscopy in understanding mechanism of PACD and effect of PI and thus, helps in individualizing patient treatment.

Introduction

Glaucoma is the second leading cause of blindness, estimated to affect almost 80 million people by the year 2020 and estimated to rise to 106 million by 2040. Glaucoma is known to be more prevalent among Asians (47% of the worldwide data). About 87% of people affected with angle-closure glaucoma disease, belong to Asian populations.[1]

In a survey published in Indian Journal of community medicine in the year 2013, glaucoma was found to be affecting 12 million people in India.[2] In the year 2010, the estimated number of people with angle-closure glaucoma (ACG) in India was 2.54 million and those with primary angle-closure disease (PACD) was estimated to be as high as 27 million.[3]

In a study in north Indian population, PACD constituted 46% of all primary adult glaucomas.[4] The previous studies have reported a significantly higher prevalence of primary angle-closure suspect (PACS) as compared to primary angle closure (PAC) and primary ACG (PACG).[5,6] The main pathophysiology of PACD is relative pupillary block.[7] Laser peripheral iridotomy (LPI) is considered as the first-line treatment for angle closure.[8] Studies have reported a persistent closed angle despite a patent iridotomy in 20–35% of patients.[9-11] This can be attributed to the multifactorial pathophysiology of ACD (thick peripheral iris roll, lens vault (LV), plateau iris, combined mechanisms, etc.).[12-14]

The previous studies suggested that 38% patients have pure pupillary block, 8–9% are caused by non-pupillary block mechanisms, while the remaining 54% results from combination of the two.[15] Although it is known that iridotomy causes angle

opening in majority cases as there is some component of pupillary block in almost 90% cases. However, the angle opening is not to the extent as expected in all cases. This indicates that non-pupillary block factors and factors such as LV and iris thickness (IT) which may act similar to non-pupillary block mechanisms might be playing a more prominent role than expected.

Gonioscopy is the current clinical gold standard to visualize anatomy of angle of anterior chamber. However, it is invasive and has limitations such as intraobserver and interobserver variability, longer learning curve, and variability due to light conditions and inability to quantify angle measurements, limiting its use in clinical research.[16] Anterior segment optical coherence tomography (AS-OCT) has emerged as an objective tool to quantify angle parameters and study changes induced by iridotomy. AS-OCT enables the estimation of anterior segment features such as iris curvature, iris cross-sectional area, anterior chamber depth (ACD), IT, anterior chamber width (ACW), and LV. Given the high prevalence of PACD in Indian population, it is imperative to understand LPI-induced anatomic changes in the Indian eyes.[16]

The purpose of this study was to compare AS-OCT angle morphology before and after LPI in a cohort of Indian subjects with PACD and to study baseline parameters associated with angle widening.

Methodology

It is a prospective interventional study. The study protocol was approved by the Institutional Review Board of the Dr. Shroff's Charity Eye Hospital. Informed consent was obtained from all participants of the study.

Subjects

One hundred and fifty-one eyes of 80 patients, 30 years or older, attending the OPD of SCEH, from April 2019 to December 2019, who were diagnosed with PAC, PACS, and PACG and underwent laser peripheral iridotomy (PI) were included in this study. Patients with the following findings were excluded from the study-eyes with secondary angle-closure (such as angle neovascularization, trauma, and intumescent cataract), previous intraocular surgery, previous laser iridoplasty and/or laser PI, patients on eye drop pilocarpine in the past 1 month, and any comorbidity that would interfere with the image acquisition (ex-corneal opacity/pterygium/pinguecula), nanophthalmos or micro-ophthalmos and any patient with iridotomy not patent on follow-up.

One hundred and fifty eyes of (age and sex matched) control group were also included in the study.

All subjects underwent Snellen visual acuity check and Goldmann applanation tonometry (GAT) examination before slit-lamp examination.

Slit-lamp examination (SLE)

All subjects underwent slit-lamp examination and gonioscopy by a glaucoma specialist. All subjects were examined with a 4-mirror Posner lens in dimly illuminated room with the eye in the primary position of gaze. Indentation gonioscopy was performed to determine if AC angle closure was due to apposition or peripheral anterior synechiae (PAS). Care was taken to avoid light falling in the pupillary area.

All subjects were classified into PACS/PAC/PACG according to the International Society for Geographical and Epidemiological Ophthalmology classification:

- PACS: ≥180° of iridotrabecular contact (ITC) and no optic disk changes, normal IOP, and no PAS
- PAC: ≥180° of ITC and no optic disk changes, with raised IOP or PAS or both
- PACG: ≥180° of ITC with optic disk changes, with raised IOP/PAS or both.

The indication for laser PI was apposition between the iris and trabecular meshwork anterior to the scleral spur in 2 or more quadrants in dark conditions on gonioscopy. This threshold is based on the gonioscopic criteria for laser PI from the Association of International Glaucoma Societies consensus on angle closure.

AS-OCT

Image was obtained before PI and 4 weeks after PI with AS-OCT using SD cirrus OCT.

It was performed under dim light with the patient in a sitting position. Images were captured at the nasal and temporal angle quadrants (0–180). All scans were conducted by a single well-trained operator. Multiple images were taken from each eye, and the highest-quality image with good visibility of the scleral spur was selected for study.

Parameters studied – angle opening distance (AOD) 500 and 750, trabecular iris space area (TISA) 500 and 750, LV, IT 500, ACD, and ACW.

Average of the nasal and temporal angle parameters was taken for analysis. LPI was performed in affected eyes using a Neodymium: Yttrium-aluminium-garnet (Nd: Yag) laser after pre-treatment with 2% pilocarpine. Laser PI was done by a glaucoma specialist and all the standard guidelines for PI including power, number of shots and size were followed. The LPIs were positioned nasally or temporally between the 3'O clock and 9'O clock positions. Preference was given to iris crypts and avoiding iris vessels when possible.

Subjects were re-evaluated after 4 weeks. Patency of PI was confirmed on retro illumination on SLE and a repeat gonioscopy and AS-OCT were done.

Post-PI patient was started on e/d prednisolone 4 times/day and e/d brimonidine 2 times/day for a week.

All subjects in control group underwent, Snellen visual acuity check-up, GAT, SLE, gonioscopy, and AS-OCT angle examination.

Statistical analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov–Smirnov

test. If the normality was rejected then non-parametric test was used.

Statistical tests were applied as follows:

1. Quantitative variables were compared using Mann–Whitney Test (as the data sets were not normally distributed) between the two groups and Wilcoxon signed-rank test was used for comparison between pre and post
2. Qualitative variables were compared using Chi-square test
3. Univariate and multivariate linear regression to find out significant factors affecting change in AOD: 500 and AOD: 750.

$P \leq 0.05$ was considered statistically significant. The data were entered into MS Excel spreadsheet and analysis was done using the Statistical Package for the Social Sciences version 21.0.

Results

One hundred and fifty-one eyes of PACD and 151 eyes of age- and sex-matched control subjects were analyzed in this study. Out of these 151 patient eyes, 70 eyes were diagnosed as PACS, 49 eyes as PAC, and 32 as PACG. About 70.20% cases were female and the mean age of patient was 51.13 ± 8.33 (mean ± SD) years. Table 1 compares all the demographics and ASOCT parameters between the cases (baseline) and controls. Both the groups were age and sex matched. At baseline, PACD cases had a significantly shallower ACD, narrower angle parameters, higher LV, more IT, and higher IOP as compared to the control group.

Gonioscopically, 71 eyes opened up (posterior trabecular meshwork seen in >2 quadrants) post PI, out of these 50 eyes opened up in all 4 quadrants, and 21 eyes opened up in 3 quadrants. Out of the 80 eyes which remained closed post PI, 27 eyes had PACG, 27 eyes had PAC, and 26 eyes had PACS. PACS eyes responded better to PI (open angles in 62.8%) as compared to PAC (open angles in 44.89%) and PACG (open angles in 15.6%). The identified factors for non-opening of angles were high LV (>500 microns) in 31.25% eyes, thick iris in 18.75%, and pre-existing PAS in 12.50% eyes. In 22.50% eyes, multiple factors such as LV, IT, and PAS were noted. In 12 eyes (15%), no evident factor could be identified as cause of angle-closure despite a patent PI.

All parameters studied on ASOCT increased after LPI, including mean ACW (11.28 mm pre-PI vs. 11.43 mm post PI; $P < 0.001$), ACD (2.17 vs. 2.21 mm; $P < 0.001$), and anterior chamber angle (ACA) (13.15 vs. 13.51 mm^2; $P < 0.001$). Among angle parameters, AOD 500 (0.09 mm pre-PI vs. 0.13 mm post PI; $P < 0.001$), AOD 750 (0.16 mm pre-PI vs. 0.23 mm post PI; $P < 0.001$), TISA 500 (0.06 vs. 0.08 mm^2; $P < 0.001$), TISA 750 (0.08 vs. 0.12 mm^2; $P < 0.001$), and scleral spur angle (9.57 vs. 15.25; $P < 0.001$) increased after LPI. Among iris and lens parameters, IT at 500 mm (0.39 vs. 0.40 mm; $P = 0.03$) and LV (488.69 vs. 489.82 microns: $P < 0.001$) increased with LPI [Table 2].

Linear regression analyses were performed to determine baseline parameters predicting angle widening, defined as a positive change in AOD 750 and AOD 500 after LPI. Univariate analysis for both changes in AOD 500 and change in AOD 750 show that a shallower ACD, lesser baseline AOD 500, AOD 750, TISA 500, TISA750, IT500, LV, scleral spur angle, and greater ACA at baseline, all predicted greater angle opening after LPI ($P < 0.05$ for all) [Tables 3 and 4].

Multivariable stepwise regression analysis adjusted for change in AOD 500 and AOD 750 demonstrated that greater LPI-induced angle opening was significantly associated with, lower baseline AOD 500, and lower ACD [Tables 5 and 6].

Table 7 shows association of LV with opening of angle. Out of the 80 eyes that remained closed post PI, 42 eyes had a LV of >500 microns.

Discussion

Our study evaluated the changes in angle parameters post-PI on AS-OCT and association between baseline parameters and LPI responses in PACD. We also did a comparison at baseline with a control group to evaluate the differences in values of factors such as IT and LV. To the best of our knowledge, this is the first such study to be conducted in North Indian population.

At baseline, factors such as ACD and angle parameters were significantly lower and LV, IT and baseline IOP were all significantly higher in eyes with PACD in comparison to the control group. These findings are concurrent with earlier studies.[17,18]

On gonioscopy, a post-PI success rate of 47% was noted in our subjects, with 71 out of 151 eyes showing open angles in more than 2 quadrants post PI. While, a statistically significant widening in all parameters of angle of anterior chamber (ACD, ACW, ACA, AOD 500, AOD 750, TISA 500, and TISA 750) post-PI was assessed by an AS-OCT scan in all patients. This difference could be due to the ability of the OCT scan to pick up a change of as minimal as 0.01 mm, which could not be assessed by gonioscopy. Furthermore, we only examined the nasal and temporal angles on AS-OCT, which could be the cause of difference in results on gonioscopy and OCT scan. Studies with long-term follow-up are required in eyes with persistent angle closure on gonioscopy but mild opening on AS-OCT, to study the natural course of disease in such eyes and also to study if there were any benefits of mild angle opening that was noticeable on AS-OCT but not on gonioscopy or it was just due to some mild intra test variability.

In the literature, persistent angle closure on gonioscopy, post PI, has been reported between 5 and 57%.[19]

The cause of this wide range could be due to the variation of definitions of persistent angle closure across literature. Furthermore, some studies use gonioscopy to evaluate success of PI while others use AS-OCT/UBM for same, which can result in discrepancy across studies. In our study, 53% eyes had persistent angle closure despite a patent PI. Major factors noted were higher LV, thick peripheral iris and presence of synechiae noted on gonioscopy pre-PI. In 15% eyes with post-PI closed angles, no apparent cause could be identified on ASOCT and these may require UBM to rule out further pathogenesis. The mean LV of eyes with unsuccessful

Table 1: Comparison of baseline parameters between cases and controls

Baseline parameters	Case (*n*=151)	Control (*n*=151)	*P* value	Test performed
Age (years)				
30–40	23 (15.23%)	24 (15.89%)	0.997	Chi square test; 0.159
41–50	44 (29.14%)	41 (27.15%)		
51–60	62 (41.06%)	64 (42.38%)		
61–70	17 (11.26%)	17 (11.26%)		
71–80	5 (3.31%)	5 (3.31%)		
Mean±SD	51.13±8.33	50.77±10.43	0.897	Mann–Whitney test; 11302.5
Median (IQR)	51 (45–55.5)	51 (43–58)		
Range	37–75	30–79		
Gender				
Female	106 (70.20%)	104 (68.87%)	0.803	Chi square test; 0.063
Male	45 (29.80%)	47 (31.13%)		
Lens status				
Clear	33 (21.85%)	24 (15.89%)	0.015	Chi square test; 12.307
NS1	30 (19.87%)	20 (13.25%)		
NS2	55 (36.42%)	85 (56.29%)		
NS3	26 (17.22%)	16 (10.60%)		
NS4	7 (4.64%)	6 (3.97%)		
IOP (mmHg)				
Mean±SD	17.89±6.19	13.34±2.93	<0.0001	Mann–Whitney test; 5877
Median (IQR)	16 (14–21)	13 (11–16)		
Range	10–38	8–20		
C: D				
Mean±SD	0.42±0.19	0.31±0.05	<0.0001	Mann–Whitney test; 7681
Median (IQR)	0.3 (0.3–0.425)	0.3 (0.3–0.3)		
Range	0.2–0.95	0.2–0.55		
ACW (mm)				
Mean±SD	11.28±0.46	12.75±0.57	<0.0001	Mann–Whitney test; 626
Median (IQR)	11.14 (11.01–11.24)	12.59 (12.26–13.43)		
Range	10.6–13.1	11.96–14.12		
ACD (mm)				
Mean±SD	2.17±0.2	3.1±0.28	<0.0001	Mann–Whitney test; 243
Median (IQR)	2.16 (2.02–2.23)	3.13(2.96–3.215)		
Range	1.85–2.86	2.36–3.51		
ACA (mm^2)				
Mean±SD	13.15±1.26	21.74±2.54	<0.0001	Mann–Whitney test; 27
Median (IQR)	13.54 (11.93–14.05)	21.83 (19.77–23.44)		
Range	10.96–15.91	14.76–26.44		
AOD 500 (mm)				
Mean±SD	0.09±0.03	0.37±0.07	<0.0001	Mann–Whitney test; 0
Median (IQR)	0.08 (0.07–0.1)	0.39 (0.31–0.4)		
Range	0.05–0.16	0.21–0.53		

(Contd...)

Table 1: (*Continued*)

Baseline parameters	Case (*n*=151)	Control (*n*=151)	*P* value	Test performed
AOD 750 (mm)				
Mean±SD	0.16±0.05	0.47±0.09	<0.0001	Mann–Whitney test; 6
Median (IQR)	0.15 (0.13–0.2)	0.5 (0.43–0.535)		
Range	0.11–0.27	0.27–0.7		
TISA 500 (mm²)				
Mean±SD	0.06±0.03	0.13±0.02	<0.0001	Mann–Whitney test; 635
Median (IQR)	0.06 (0.04–0.07)	0.12 (0.12–0.15)		
Range	0.02–0.15	0.09–0.18		
TISA 750 (mm²)				
Mean±SD	0.08±0.02	0.23±0.03	<0.0001	Mann–Whitney test; 63
Median (IQR)	0.08 (0.07-0.09)	0.23 (0.21-0.25)		
Range	0.04-0.17	0.15-0.29		
IT 500 (mm)				
Mean±SD	0.39±0.09	0.31±0.02	<0.0001	Mann–Whitney test; 2436.5
Median (IQR)	0.36 (0.333–0.387)	0.31 (0.305–0.324)		
Range	0.29–0.71	0.27–0.35		
LV (microns)				
Mean±SD	488.69±145.47	358.5±84.17	<0.0001	Mann–Whitney test; 4908
Median (IQR)	430 (376–613.5)	329 (302–396)		
Range	288–841	251–567		
Scleral spur Angle (degrees)				
Mean±SD	9.57±2.45	33.85±3.43	<0.0001	Mann–Whitney test; 0
Median (IQR)	10 (8-11)	34 (32-36)		
Range	4-15	25-39		

SD: Standard deviation, LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, IQR: Interquartile range, TISA: Trabecular iris space area, IT: Iris thickness, ACW: Anterior chamber width

PI was 563 microns and that with successful PI was 405 microns. Similarly, mean IT 500 was 0.422 mm in eyes with unsuccessful PI as compared to 0.346 in eyes with successful PI.

A finding that was distinct in our study was the negative association noted between LV and change in AOD 500 and AOD 750 on univariate analysis. This concluded that a larger LV at baseline was associated with less opening of angle post PI. This finding was inconsistent with findings of Zebardast *et al.*, How *et al.* and Lee *et al.*[20-22] Huang *et al.*, reported no association between LV and angle widening.[23] Around 50 eyes included in our study had a LV of >500 microns, highest being 841 microns. Previously done studies on LV reports that it acts by multiple mechanisms which include both relative pupillary block and direct pushing mechanism causing angle crowding.[12,14,24,25] Despite relieving the pupillary block by PI, the pushing mechanism cannot be eliminated. This could cause persistent crowding at the angle despite a patent PI.

Most of the previous studies have studied IT 750 and IT 2000 as angle widening parameter. However, eyes can have a thick peripheral iris roll near root of iris, which can play significant role in angle closure. Therefore, we choose to study IT 500 and, in our study, thinner baseline IT500 was associated with better LPI outcome when using AOD 500/AOD 750 change as an outcome measure. This suggests that eyes with thick peripheral iris at baseline may not show considerable AC angle opening despite patent LPI, therefore maintaining narrow angles. Similar results have been demonstrated by Sung *et al.* and Esfandiari *et al.*[26,27] A positive association was noted by How *et al.*,[21] whereas Lee *et al.* found a negative relationship.[22] Thick peripheral iris roll may cause more crowding at the angle despite of flattening of iris after PI, resulting in narrower AOD and TISA as compared to eyes with thinner baseline IT. Furthermore, in relative pupillary block mechanism, thinner irises tend to bulge forward more as compared to thicker irises.[28] PI can treat pupillary block reducing this bulging and result in better angle widening.

Greater angle widening was noted in eyes with shallower ACD and narrower angles at baseline. Furthermore, lesser AOD

Table 2: Comparison of ACW, ACD, ACA, AOD 500, AOD 750, TISA 500, TISA 750, IT 500, LV, and angle between pre and post

Parameters	Pre (n=151)	Post (n=151)	P value	Test performed
ACW (mm)				
Mean±SD	11.28±0.46	11.43±0.49	<0.0001	Wilcoxon Signed-Ranks Test; z value=9.600
Median (IQR)	11.14 (11.01–11.24)	11.25 (11.09–11.77)		
Range	10.6–13.1	10.62–13.02		
ACD (mm)				
Mean±SD	2.17±0.2	2.21±0.19	<0.0001	Wilcoxon Signed-Ranks Test; z value=9.445
Median (IQR)	2.16 (2.02–2.23)	2.19 (2.075–2.28)		
Range	1.85–2.86	1.91–2.85		
ACA (mm^2)				
Mean±SD	13.15±1.26	13.51±1.57	<0.0001	Wilcoxon Signed-Ranks Test; z value=9.128
Median (IQR)	13.54 (11.93–14.05)	13.67 (11.92–14.91)		
Range	10.96–15.91	10.97–15.92		
AOD 500 (mm)				
Mean±SD	0.09±0.03	0.13±0.07	<0.0001	Wilcoxon Signed-Ranks Test; z value=8.396
Median (IQR)	0.08 (0.07–0.1)	0.11 (0.09–0.168)		
Range	0.05–0.16	0.05–0.32		
AOD 750 (mm)				
Mean±SD	0.16±0.05	0.23±0.11	<0.0001	Wilcoxon Signed-Ranks Test; z value=9.476
Median (IQR)	0.15 (0.13–0.2)	0.19 (0.14–0.29)		
Range	0.11–0.27	0.11–0.51		
TISA 500 (mm^2)				
Mean±SD	0.06±0.03	0.08±0.03	<0.0001	Wilcoxon Signed-Ranks Test; z value=8.464
Median (IQR)	0.06 (0.04–0.07)	0.07 (0.05–0.09)		
Range	0.02–0.15	0.03–0.19		
TISA 750 (mm^2)				
Mean±SD	0.08±0.02	0.12±0.05	<0.0001	Wilcoxon Signed-Ranks Test; z value=8.719
Median (IQR)	0.08 (0.07–0.09)	0.11 (0.08–0.15)		
Range	0.04–0.17	0.06–0.25		
IT 500 (mm)				
Mean±SD	0.39±0.09	0.40±0.09	<0.0001	Wilcoxon Signed-Ranks Test; z value=4.673
Median (IQR)	0.36 (0.333–0.387)	0.36 (0.336–0.39)		
Range	0.29–0.71	0.3–0.7		
LV (microns)				
Mean±SD	488.69±145.47	489.82±145.95	<0.0001	Wilcoxon Signed-Ranks Test; z value=6.309
Median (IQR)	430 (376–613.5)	431 (376–614.5)		
Range	288–841	290–842		
Scleral spur angle (degrees)				
Mean±SD	9.57±2.45	15.25±7.81	<0.0001	Wilcoxon Signed-Ranks Test; z value=9.024
Median (IQR)	10 (8–11)	12 (9–20)		
Range	4–15	5–36		

SD: Standard deviation, LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, IQR: Interquartile range, TISA: Trabecular iris space area, IT: Iris thickness, ACW: Anterior chamber width

Table 3: Univariate linear regression to find out significant factors affecting change in AOD 500

Change in AOD 500	Beta coefficient	Standard error	*P* value	Lower bound (95%)	Upper bound (95%)
Age (years)	−0.001	0.001	0.128	−0.002	0.000
IOP (mmHg)	−0.002	0.001	0.071	−0.003	0.000
C: D	−0.031	0.029	0.291	−0.089	0.027
ACW (mm)	−0.014	0.012	0.276	−0.038	0.011
ACD (mm)	−0.065	0.028	**0.020**	−0.121	−0.010
ACA (mm²)	0.017	0.004	**0.0002**	0.008	0.025
AOD 500 (mm)	−0.934	0.199	**<0.0001**	−1.328	−0.540
AOD 750 (mm)	−0.813	0.106	**<0.0001**	−1.022	−0.603
TISA 500 (mm²)	−0.794	0.216	**0.0003**	−1.220	−0.368
TISA 750 (mm²)	−0.785	0.222	**0.001**	−1.223	−0.347
IT 750 (mm)	−0.217	0.059	**0.0003**	−0.333	−0.101
LV (microns)	−0.0001	0.000	**0.007**	−0.00018	−0.00029
Angle (degrees)	−0.007	0.002	**0.002**	−0.014	−0.006

LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, TISA: Trabecular iris space area, IT: Iris thickness, ACW: Anterior chamber width

Table 4: Univariate linear regression to find out significant factors affecting change in AOD 750

Change in AOD 750	Beta coefficient	Standard error	*P* value	Lower bound (95%)	Upper bound (95%)
Age (years)	−0.001	0.001	0.170	−0.003	0.000
IOP (mmHg)	−0.002	0.001	0.031	−0.004	0.000
C: D	−0.053	0.034	0.127	−0.120	0.015
ACW (mm)	−0.010	0.015	0.497	−0.039	0.019
ACD (mm)	−0.107	0.032	**0.001**	−0.170	−0.043
ACA (mm²)	0.022	0.005	**<0.0001**	0.012	0.031
AOD 500 (mm)	−0.995	0.236	**<0.0001**	−1.461	−0.529
AOD 750 (mm)	−0.680	0.136	**<0.0001**	−0.947	−0.412
TISA 500 (mm²)	−0.905	0.253	**0.0005**	−1.405	−0.406
TISA 750 (mm²)	−0.997	0.257	**0.000**	−1.505	−0.489
IT 750 (mm)	−0.280	0.068	**<0.0001**	−0.414	−0.146
LV (microns)	−0.00013	0.000	**0.003**	−0.00022	−0.00044
Angle (degrees)	−0.011	0.003	**<0.0001**	−0.016	−0.009

LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, TISA: Trabecular iris space area, IT: Iris thickness, ACW: Anterior chamber width

Table 5: Multivariate linear regression to find out significant factors affecting change in AOD 500 after removing multicollinearity

Change in AOD 500	Beta coefficient	Standard error	*P* value	Lower bound (95%)	Upper bound (95%)
ACD (mm)	0.071	0.028	**0.018**	0.013	0.129
ACA (mm²)	0.009	0.010	0.3949	−0.012	0.029
AOD 500 (mm)	−1.649	0.148	**<0.0001**	−1.955	−1.343
AOD 750 (mm)	−0.513	0.084	**<0.0001**	−0.686	−0.339
TISA 500 (mm²)	0.910	0.264	0.0922	0.365	1.456
TISA 750 (mm²)	−0.200	0.284	0.488	−0.789	0.388
IT 750 (mm)	−0.022	0.093	0.8136	−0.214	0.170
LV (microns)	0.000	0.000	0.603	0.000	0.000
Angle (degrees)	−0.008	0.001	**<0.0001**	−0.011	−0.006

LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, TISA: Trabecular iris space area, IT: Iris thickness

Table 6: Multivariate linear regression to find out significant factors affecting change in AOD 750

Change in AOD 750	Beta coefficient	Standard error	*P* value	Lower bound (95%)	Upper bound (95%)
ACD (mm)	−0.095	0.047	**0.054**	−0.191	0.002
ACA (mm^2)	0.002	0.017	0.9025	−0.033	0.037
AOD 500 (mm)	−1.251	0.247	**<0.0001**	−1.762	−0.740
AOD 750 (mm)	−0.303	0.140	**0.051**	−0.593	−0.014
TISA 500 (mm^2)	0.760	0.440	0.0978	−0.151	1.671
TISA 750 (mm^2)	0.174	0.475	0.717	−0.808	1.157
IT 750 (mm)	−0.138	0.155	0.3819	−0.459	0.183
LV (microns)	0.000	0.000	0.117	−0.001	0.000
Angle (degrees)	−0.010	0.002	**0.0002**	−0.015	−0.005

LV: Lens vault, AOD: Angle opening distance, ACD: Angle-closure disease, ACA: Anterior chamber angle, TISA: Trabecular iris space area, IT: Iris thickness

Table 7: Association of post-gonioscopy with LV

Post gonioscopy	<500 (*n*=101)	>500 (*n*=50)	Total	*P* value	Test performed
Closed	38 (37.62%)	42 (84%)	80 (52.98%)	<0.0001	Chi square test, 28.874
Open	63 (62.38%)	8 (16%)	71 (47.02%)		
Total	101 (100%)	50 (100%)	151 (100%)		

LV: Lens vault

500 and lesser TISA500 at baseline were related to a greater change in AOD 500 and AOD 750 seen after LPI. Similar to our results, Esfandiari *et al.*, Zebardast *et al* and Lee *et al.*, also found an inverse association between baseline angle width parameters and the degree of LPI induced angle widening.[20,22,27] They also found an inverse association between baseline angle width parameters and the degree of LPI-induced angle widening. Lesser baseline angle parameters are associated with greater pupillary block, which is treated by the help of PI, thus, resulting in wider angle opening seen in such cases.

The pathophysiology of angle-closure disease is multifactorial. The commonly known mechanisms include pupil block, plateau iris configuration, thick peripheral iris, and increased anterior LV and combined mechanisms. Although PI is considered as a treatment choice for all cases of PACD, it may not be equally effective in patients who have pathology other than pupillary block, such as thick LV, thick iris, and plateau iris. Gonioscopy may not be affective in identification of the exact pathophysiology of angle closure in all cases. AS-OCT can be a good adjunct in finding the pathophysiology of angle closure and may help to device a systematic approach to management of PACD by categorizing eyes, in which PI might be more beneficial.

Limitations

We attempted to keep variations in analysis of AS-OCT minimal by allowing a single trained operator to capture and evaluate all images. Despite these measures, there are certain limitations of our study. The use of 2D-AS-OCT images also limit our knowledge about factors such as iris volume and its effect on angle opening. Furthermore, studying of effect of anterior LV in relation to ACD (known as relative LV) might be needed to explain the variations in association of LV with angle opening seen across the literature. In 12 patients, plateau iris was clinically suspected, but a confirmatory diagnosis could not be done as UBM was not performed.

Conclusion

Gonioscopy is a good tool for clinical assessment but is insufficient in quantifying angle parameters. Combining gonioscopy with a baseline ASOCT can give us better understanding of the pathophysiology and thus help us in prognosticating the effect of PI on angle widening. This can help in devising a better treatment strategy for all patients and help to individualize the management of PACD.

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